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POWER AND THE ENGINEER

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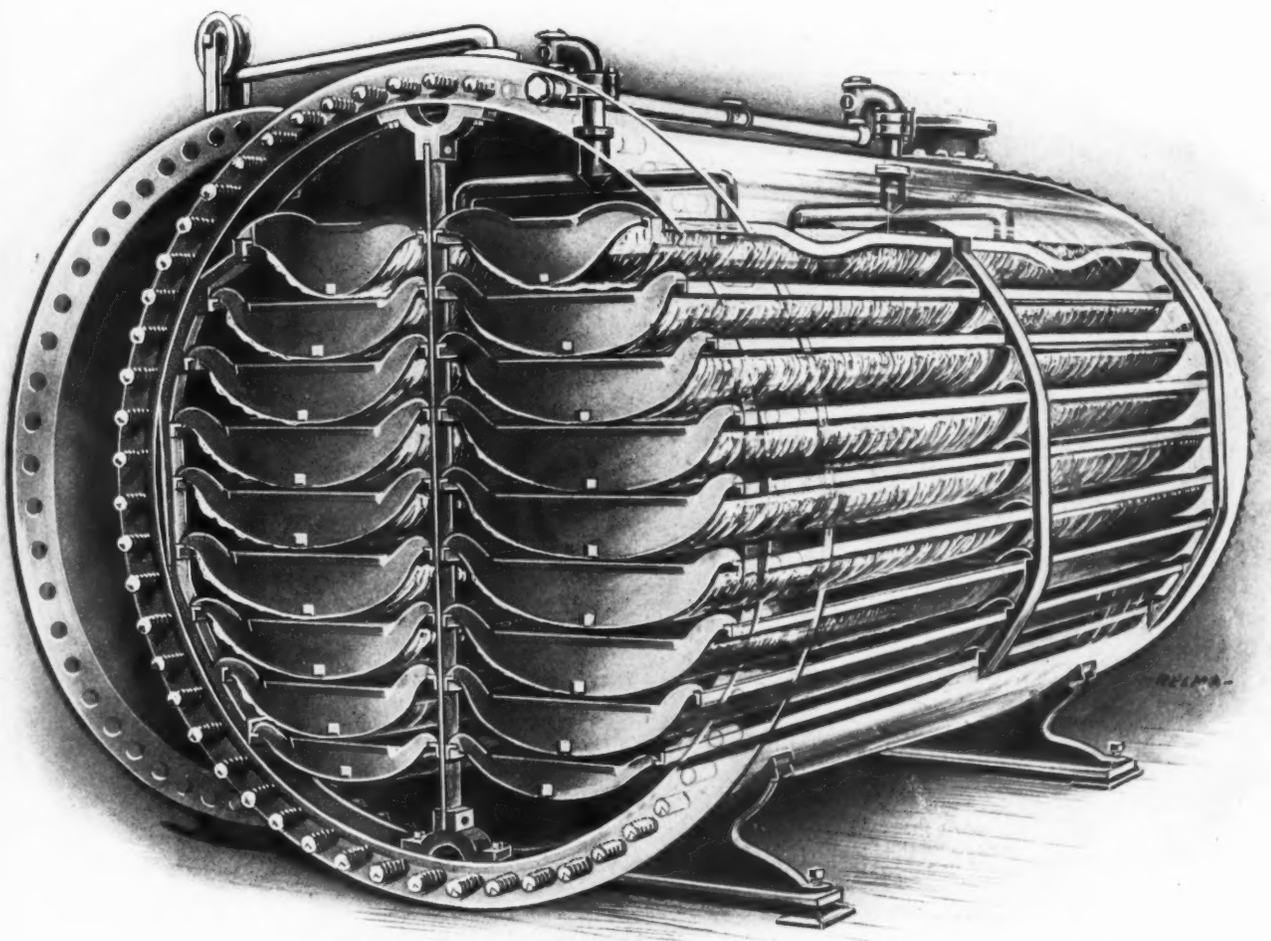
Vol. 29. Index to Advertisers and Classified Index Following Reading Matter No. 8.

Hoppes Live Steam Feed-Water Purifiers

Keep Boilers Clean Without the Use of Chemicals.



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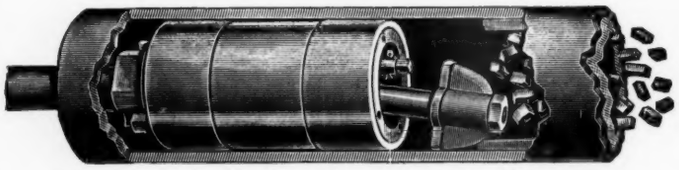
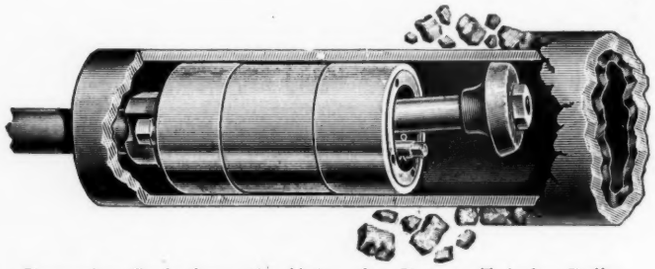
If the fuel bills are high, he growls, but fails to find out **why** they are high.



Removing Scale from the Tube of a Water Tube Boiler.



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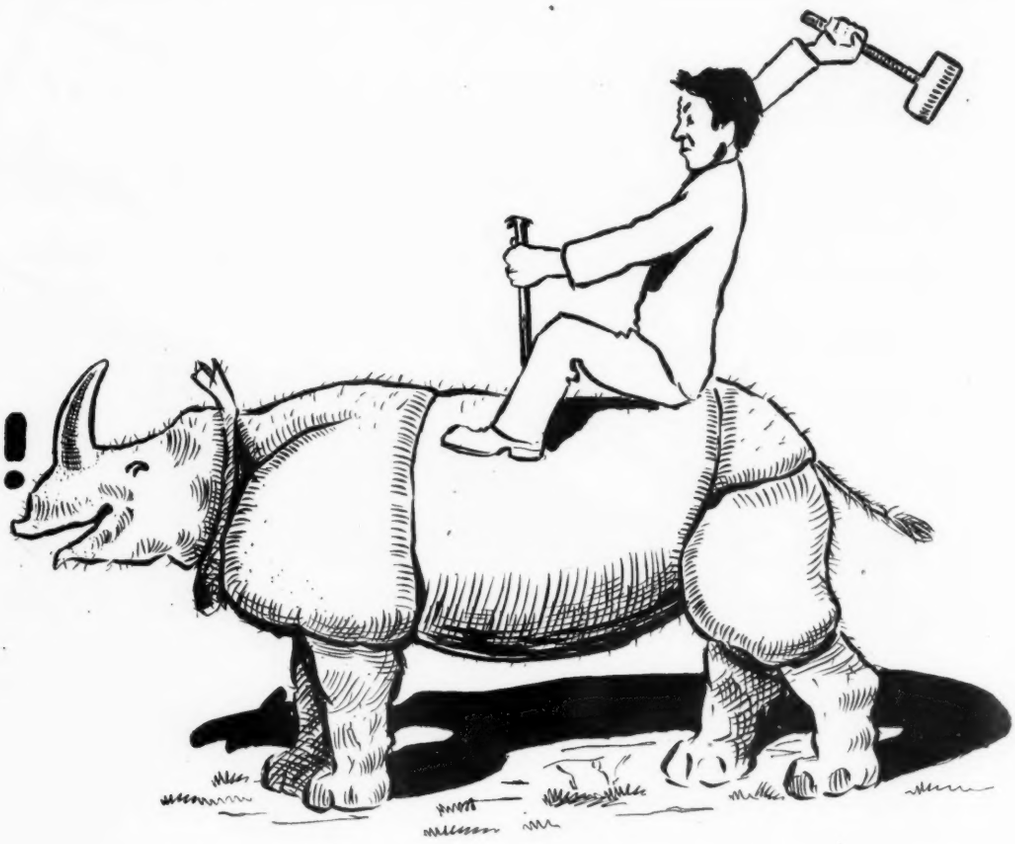

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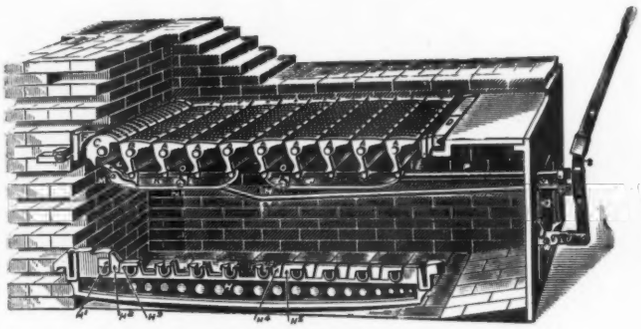
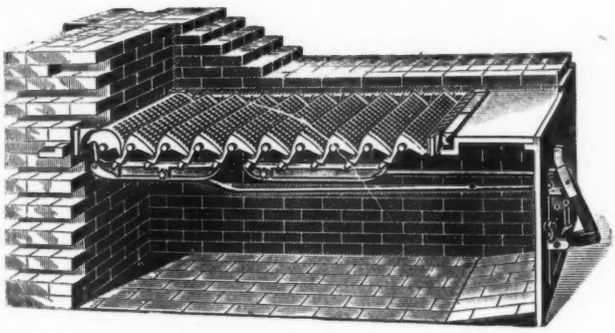
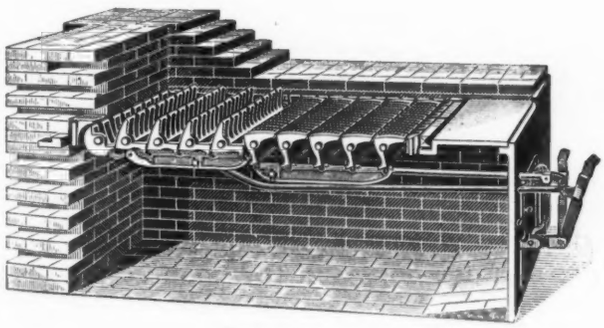


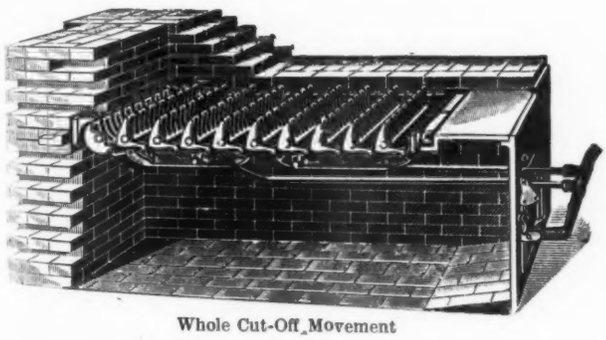
Normal Position of Grate



Shaking Movement



Divided Cut-Off



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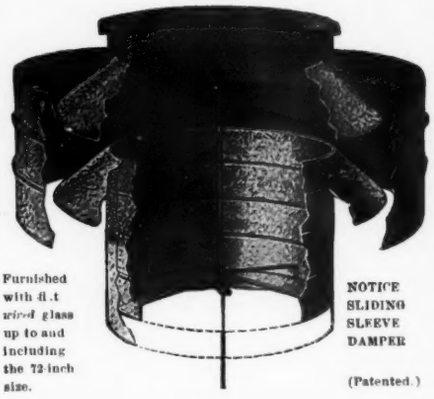

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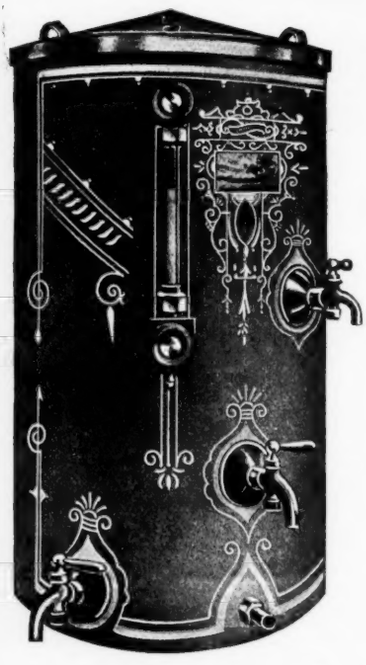

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An Air Receiver and Pipe Line Explosion

Disastrous Accident to a Compressed Air System, Pointing to the Need of Thorough Cleaning and Proper Drainage and Lubrication

BY S. A. NEWTON

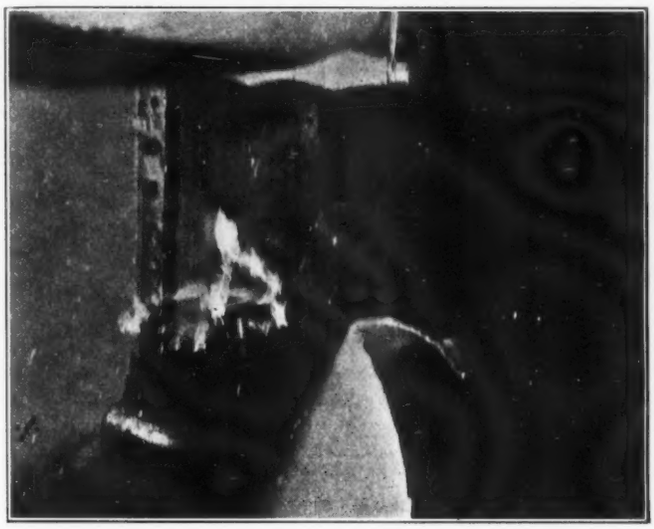


FIG. 1

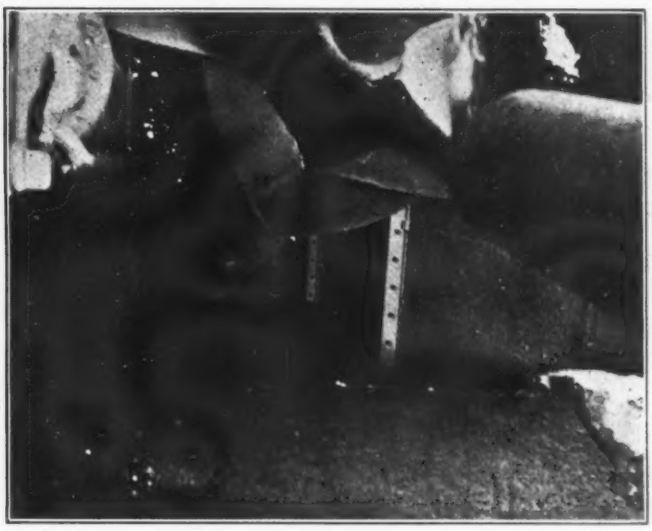


FIG. 2

A striking example of the danger existing from the use of ordinary engine oil in the air cylinders of air compressors operating at pressures in the neighborhood of 100 pounds or more was set forth in a recent violent explosion, of a 300-foot section of 8-inch heavy wrought-iron pipe line and air receivers or reservoirs, occurring last June at one of the large railroad shops in the East.

Within an hour after starting up the shops in the morning the employees in the large modern power house, situated 300 feet from the main shops, which are supplied with steam-, electric- and air-power mains through a concrete tunnel or subway, were startled by a dull roar, and the engine room, in which are located the air compressors and steam-electric equipment, was completely filled with heavy smoke and gas. The air compressors were immediately shut down and as soon as the smoke was cleared away an inspection revealed a huge hole blown through the floor and the air reservoirs and piping in the basement in ruins, the wreckage extending in a tangled mass from the compressors through the tunnel to the shops. Fig. 8 is a cross-section of the engine room, showing the air reservoirs and pipe line. At the time of the explosion two cross-compound, two-stage compressors were pumping approximately 5000 cubic feet of free air per minute, discharging at from 95 to 100 pounds pressure through a series of four cylindrical tanks, these tanks forming in reality one large air reservoir, from the last tank of which an 8-inch line leads to the shops. The heavy pipe connections were broken at the points indicated; the tanks were moved from their positions; the bottom head of tank No. 3 was torn completely off through the bottom line of rivets and the tank rose through the 10-inch reinforced concrete floor and dropped back into the basement in the position shown in Figs. 5 and 7. A rope sling was placed around tank No. 3 preparatory to hoisting it to the engine-room floor. Fig. 5 shows the ruptured head and the bulged-out bottom of tank No. 4. The tanks were built of ¼-inch boiler-iron sides and 3/8-inch boiler-iron tops and bottoms, the tops being convex and the bottoms concave from the outside. The heads of the other three tanks were bulged out to the limit set by the basement floor and the engine-room floor girders 8 feet 9 inches above. That all the tanks were not ruptured was probably due to the fact that Nos. 1, 2 and 4 were set directly under the steel floor girders and held by them.

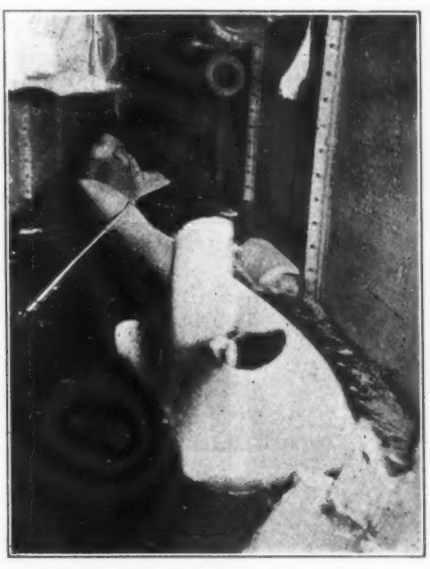


FIG. 3

But the pipe line was the scene of the most violent explosion. Three hundred feet of 8-inch wrought-iron pipe, 5/16-inch thick, was utterly destroyed, being bent and twisted into the fantastic shapes shown in Figs. 1, 2, 3, 4 and 6. Fig. 2 shows one length of pipe split and actually wound around a parallel 10-inch steam line. Fig. 3 shows another length split and bent upon itself at one end. In both these views the ends of the connecting lengths are visible. Fig. 6 shows a clean split for the entire length of the section with a clean edge, as though the pipe had been of cardboard cut through with a sharp knife. Fig. 4 shows the wreckage near the trap located in the center of the line. Here the pipe is twisted as though of paper.

Theories as to the Cause

Two theories were advanced as to the cause of the explosion: Weak construction of the reservoir tanks and consequent failure; and the formation of a gas from the oil used in the air cylinders of the compressors, which gas mixed with the air

FIG. 4

FIG. 5

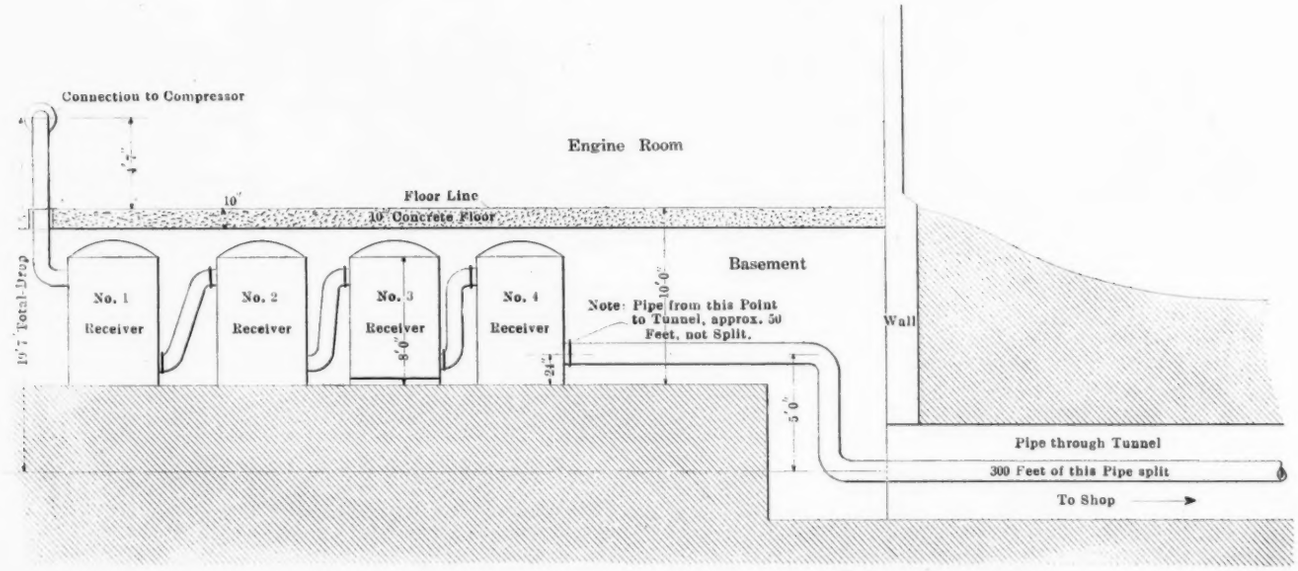


FIG. 8. GENERAL ARRANGEMENT OF COMPRESSED-AIR RECEIVERS AND PIPING

(Breaks caused by explosion shown by lines across parts)

FIG. 6

FIG. 7

and particles of dust were ignited by the unusually high temperature of the air on the morning of the explosion, producing much the same conditions as those of the dust explosions in coal mines, an occurrence of which we know more of the effect than the cause.

As to the theory that the tank first gave way, an examination of its structure shows a strength far in excess of the 100 pounds per square inch imposed upon it. And all the tanks were equipped with large pop safety valves set at 110 pounds, and which were in perfect working order. Then it would be difficult to account for the havoc wrought with the pipe line if the tank simply gave way, for in that case it would hardly be expected that a pipe-line damage would be greater than a few broken joints.

The pipe was evidently subjected to the greater stress, there being two separate explosions, the first and more violent in the pipe line directly causing that in the receivers. The writer, as an eye-witness, can only so account for the dense cloud of smoke and damage wrought. A good deal of dust would naturally be raised by such an outrush of 600 cubic feet of air at 100 pounds pressure, but a heavy carbon smudge continuing for some little time after the outburst can hardly be accounted for by other than a rapid explosive combustion.

An examination of Fig. 1, showing the piping lay-out, brings forth the excellent low places for the collection of oil and dust which come over from the air cylinders. The four tanks were provided with drain or blow-off cocks which were placed 3 *inches above the bottom* of the tanks, and there was a good indication that the tanks were filled to the level of these cocks with the mixture of oil and dust.

It is an established fact, set forth by a number of unfortunate examples, that air receivers are liable to explosion from accumulated oil deposits, which, with the dust and compressed air at high temperatures (Kent gives the temperature rise from atmospheric at 60 degrees Fahrenheit to 100 pounds as 425 degrees Fahrenheit over the temperature of induction) will, under favorable conditions, form a very powerful explosive gas with a flash point not far from the temperature of the compressed air. In this case ordinary engine oil was used in the air cylinders, which were lubricated by automatic lubricators.

The occurrence shows the need of proper drainage and the use of oil of a high flash point for the lubrication of the air cylinders of air compressors, and, most important, the regular and thorough cleaning of all reservoirs and likely places of deposit in the air line. It is interesting to note that a large radiator for the after-cooling of the air was in course of construction at the time of the explosion. Had this after-cooler been in use the danger might have been eliminated from the pipe line, as the oil would have been precipitated on the cooling of the air.

Trade Opportunities in Argentina

By M. De Moreira

Among all the republics of South America, Argentina deserves our special attention and study. She has gone ahead so rapidly that it is safe to predict that she will have a brilliant future. Her keen rivalry with Brazil, the richest country in South America, makes the struggle for supremacy still more interesting and, at the same time, stimulates industry and commerce. Although essentially an agricultural country there are, nevertheless, many opportunities for the manufacturers of machine tools.

The first thing to do when considering foreign exports is to study the financial conditions of the country where one wishes to establish his goods. There is no country in South America that can give a better showing than Argentina, whose revenues for the year 1907 were estimated at $94,000,000, whereas the receipts reached the total amount of $105,500,000, or $11,000,000 in excess of the estimate. The bank balances in the republic on December 31 last, showed deposits of $783,000,000 and cash reserves of $311,000,000. The foreign commerce of Argentina for 1907 is stated as nearly $600,000,000, a total greater than that of China or Japan, and was composed of imports $285,860,683 and exports $296,204,369. In the distribution of imports the United States takes the third place with $38,842,277; England and Germany come first and second, respectively, and each has an import far superior to ours. This is due to lack of good traveling representatives, intelligible catalogs, knowledge of the people, banking facilities, etc.

Railway, Highway and Shipbuilding Opportunities

American manufacturers have an excellent opportunity to furnish machine tools for railway shops, as Argentina is literally gridironed with railways. Its lines cover 14,000 miles and have an invested capital of $67,688,876. There are besides 250 miles of secondary lines and roads, and a new line is being built to Bolivia. The English, however, are using all their efforts to obtain the contracts to supply the necessary materials.

It seems to me appropriate to remind the manufacturer who ships his goods to Argentina to follow minutely the instructions of the buyer as to the sizes of packages and boxes. The reason for this is that the gage of the railway in Argentina is variable and goods shipped into the interior may go over broad, medium or narrow-gage lines. These 14,000 miles of road belong to twenty-two companies, of which eighteen have uptodate repair and building shops requiring machine tools, etc.

Besides going ahead with railways, Argentina is perfecting her highways and bridges. The bureau of bridges and roads of the Argentina republic has $1,500,000 to spend for construction work, out of which nearly a million dollars will go for bridges alone. The chances are that the contracts for the building of these bridges will be given to a native engineer, who has been educated abroad, and a wide-awake American manufacturer can easily, it seems to me, obtain a contract to furnish some of the needed materials and machinery.

Shipbuilding is also increasing. The River La Plata is a very busy thoroughfare and the commerce between Buenos Aires and Montevideo is extensive. Many launches, sailing vessels and steamboats are built at the shipbuilding docks at La Plata. The government dry dock and repair shops for the navy are uptodate. The docks in Buenos Aires are as modern as those of New York, and although the hoisting machinery is nearly all English, still there is a chance for American manufacturers to have theirs used in the new docks.

Activity in rail and water shipping is a sure sign of the industrial progress of a nation. Indeed, the development of industries in Argentina is increasing every year. Sawmills, refrigerating plants, sugar refineries and machinery for mines are shipped from England and Germany.

In regard to mines it must be recognized that the production of minerals throughout the republic is small; however, the Bora deposits and mines at Salta and Jujuy are giving great results. The latter belong to an Anglo-German syndicate that has made large purchases of mining machinery in Europe. Gold, silver, copper, tin and lead are also worked in the southern part of the republic.

Printing Machinery Opportunities

Printing machinery and all the equipment pertaining thereto will find a ready market in Argentina, as the newspaper plants are modern in all their details. The latest statistics that I have been able to obtain show that in one year Argentina has imported printing machinery to the value of $78,388, of which only $7692 came from the United States; the rest was supplied by Germany. American typesetting machines have been successfully introduced, but the manufacturers have made no serious efforts to push their sale; apparently they are satisfied to have sold a couple of them. Some rotary presses manufactured in the United States have been bought by an Argentina newspaper and given great satisfaction, and I am positive that a good business could be obtained if the manufacturers of that kind

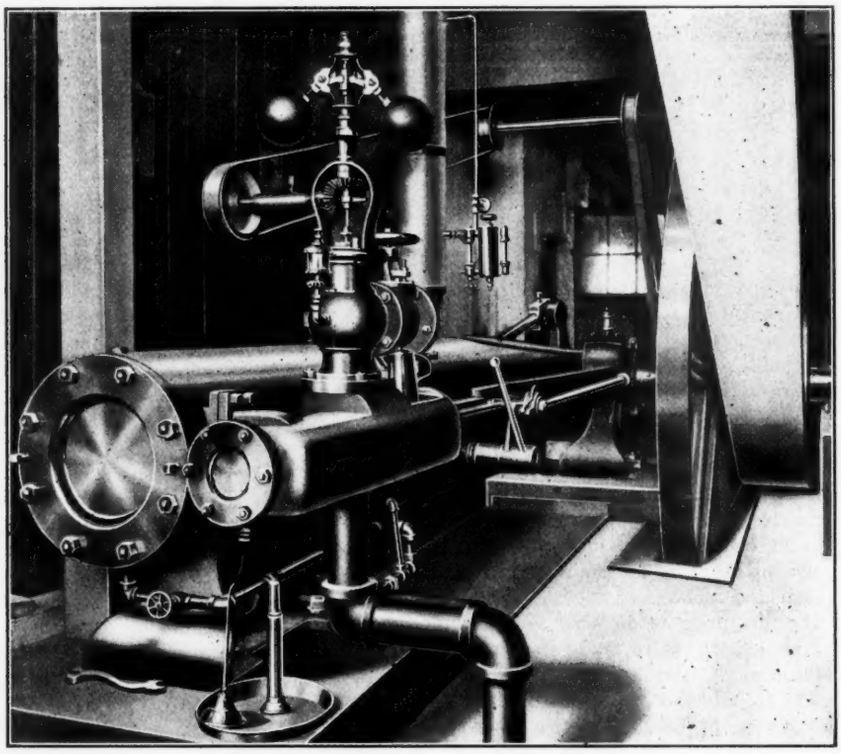


FIG. I. PISTON THROTTLE-VALVE ENGINE

of press would send to Argentina a man conversant with the language of the country, who would make some arrangements with an established house in Buenos Aires to carry them in stock.

A positive proof that the Argentinians are desirous of obtaining the best machines and machine tools is, that in September, 1907, they passed a law exempting from customs duty during the period of ten years, machinery, tools and materials necessary for the installation and working of mining and metallurgical establishments which may be erected or which actually exist in the republic, also machinery, tools and materials for well boring. The only thing, therefore, that the manufacturer has to do is to apply in writing to the custom house through which he desires to effect importation and to pay the charges involved in the verification of the materials.

Our system of steel structures for buildings is being adopted there and in Buenos Aires an eight-story house is being constructed by Americans with materials from the United States; as a rule, however, the steel and the machinery are imported from England, Germany or France.

Great Wealth and Corresponding Opportunities

When one sees the wealth of Argentina, its fine railways, its splendid dock system, its modern buildings, its well equipped factories—when one becomes acquainted with the natives and finds them educated, brilliant, ambitious, desiring to obtain the best each nation can give—one wonders why the American manufacturer does not avail himself of these great opportunities, but lets them slip through his fingers, prefering to endow his foreign competitors with a wealth that could be his.

It may be that he does not know that the once solicited long-term credits which he was not willing to extend are being done away with and that there is a tendency to purchase directly from him for cash against documents. It may be that banking methods of South American countries which result in loss of valuable time and other disadvantages to the development of the American trade would naturally disappear with the establishment of an American bank; it is, nevertheless, true that this slow development is the result of the North American lack of interest, due partially to the ignorance of the wealth in store for him who will study the South American export question as he should.

Piston Slide Valve Throttling Engine

There are many designs of slide-valve engine to be seen in a day's journey, but a piston slide-valve throttling engine is out of the ordinary, and not likely to be met with very often. Fig. 1 shows an engine of this type which has been in use for 26 years in its present location and was a second-hand engine when purchased. That it is still doing good work is evident, as the owner and the engineer speak highly of it.

The engine operates at 72 revolutions per minute, with a steam pressure of 80 pounds. By referring to Fig. 2, it will be seen that the steam chest is bolted to the cylinder, which is 14x36 inches in

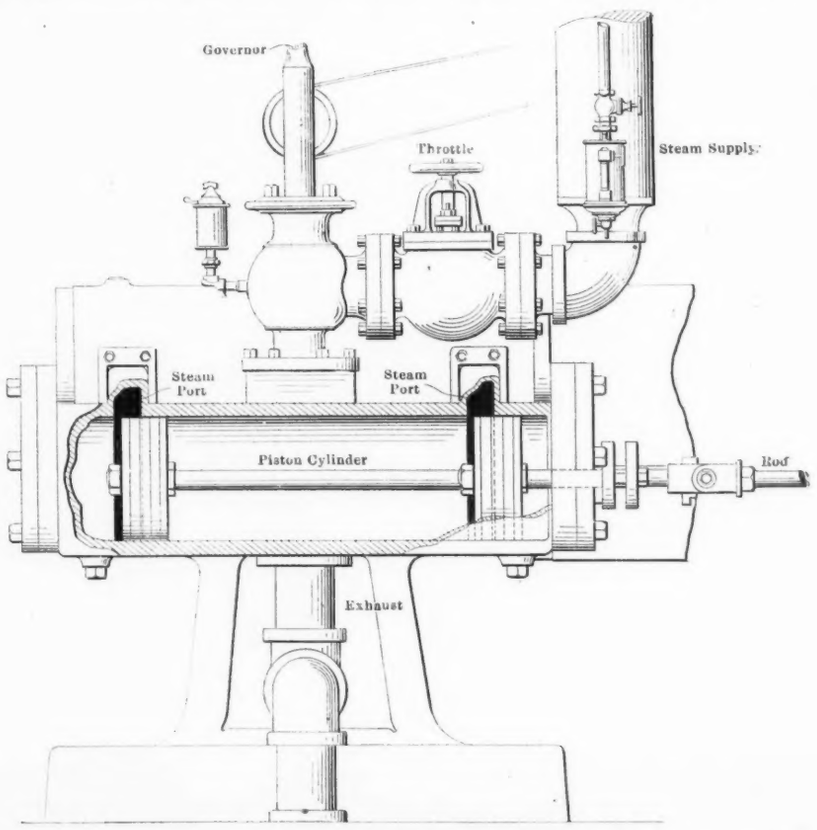


FIG. 2. SECTION OF STEAM CHEST

size. The interior of the steam chest is shown in Fig. 2. The valve consists of two piston heads, each fitted with two snap rings. These pistons are fitted to the piston-rod and kept in place by nuts, by means of which adjustments are made.

By referring to Fig. 1, it will be seen that someone made a slight blunder in putting on the governor. In order to operate the governor in its present position, it was necessary to run a line shaft above the engine shaft, and belts from this shaft to the governor. It would have been far easier to have changed the top of the governor so that the wheel would come in line with the governor pulley on the engine shaft.

Compression in Gas Engines

By H. W. Jones

This matter of compression has been talked of and argued over, hashed and re-hashed, but a glance at the accompanying indicator diagrams will show that the subject has not been exhausted. The writer is in close touch with more than 700 gas engines of various sizes and makes operating on ordinary illuminating gas, and has asked a number of makers of gas engines why they don't put higher compression in their engines. Here are some of the reasons they give for not doing so:

The mixture will pre-ignite if compression is raised above a certain moderate degree (opinions differ, even on the same gas); the cylinder and pistons wear at such a rate as to make high compression a menace; high compression will pound out the piston pin and connecting-rod brasses. Now for a few *facts*, not arguments or theorization.

F. X. Parsche & Son, 524 Orleans street, Chicago, manufacturing cut glass and special glass decorations, have a large factory containing some very high-grade machinery. They have in their factory a 15-horse-power two-stroke-cycle Bessemer gas engine, pulling about 12 horse-power on an average of nine hours per day. This engine has been in constant operation for about four years and the writer has been assured by Mr. Parsche that he has never spent a dollar on repairs for this engine, except for igniter points. The piston, cylinder and crosshead, were all examined by me personally during the last month and the condition of each was almost ideal; this is especially true of the cylinder.

Mr. Parsche needed more power a few months ago, having installed a new machine for his work, and appealed to me to see if he could get more power from his engine. After examining the engine I advanced the ignition point to 15 degrees ahead of center, and he now gets all the power he needs out of the engine; moreover, his gas bills are less than before his power was increased. The engine runs now at about 135 revolutions per minute; it will pre-ignite if speeded up to 180 revolutions per minute, and run at full capacity, because the igniter becomes red hot.

After we had set the igniters ahead we decided to see what the compression was. Fig. 1 is the diagram taken with a 100-pound spring. (The diagram is reproduced exactly the same size as the original.)

I was astounded; so were all who witnessed the test. But we were interested enough to invite the experts of four different engine builders to verify the test, and they were glad to come and bring their indicators; Fig. 2 is the compression diagram taken by them, and Fig. 3 is a diagram taken with about 12 horse-power load, at 130 revolutions per minute, with the igniter set to break 15 degrees ahead of dead center. This engine will not pre-ignite at all at 135 revolutions per minute, no matter what the load.

Note if you please how perfectly the exhaust drops down to atmospheric pressure at the end of the stroke, and that the compression is 190 pounds full, the explosion pressure 525 pounds full and the mean effective pressure about 65 pounds. These cards were not taken carelessly; three different tests were made with a different indicator each time, and the results agreed with remarkable closeness. This engine is running every day, and will apparently continue to run right along.

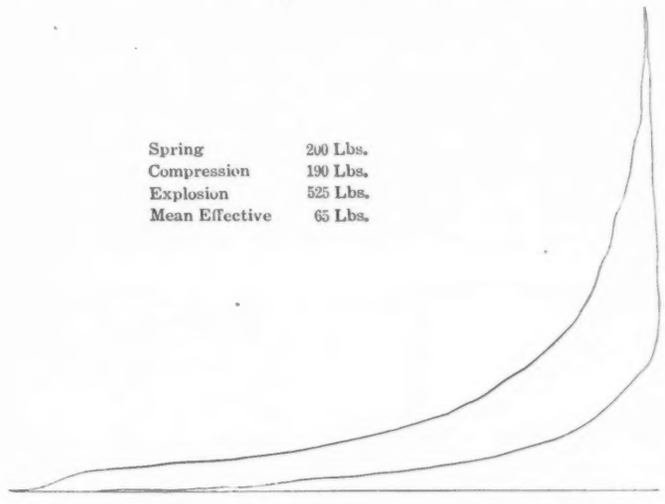


FIG. 3. FULL-LOAD DIAGRAM

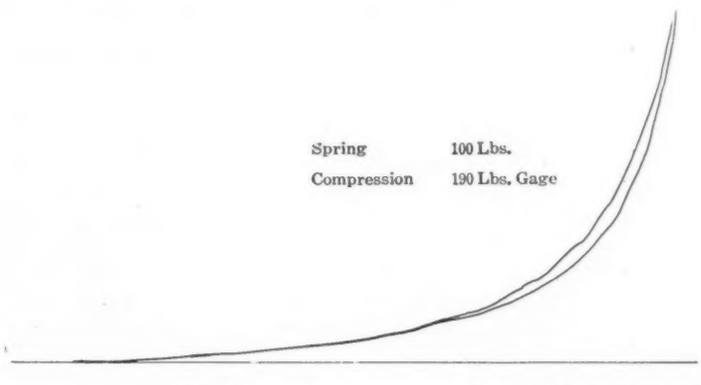


FIG. 1

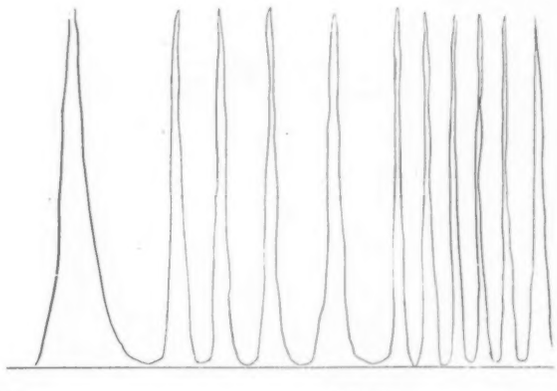


FIG. 2

COMPRESSION DIAGRAMS

Combined Power and Hot Water Heating Plant

General Management of the Special Apparatus Required, Preceded by a Description of the Arrangement and Operation of the Plant

BY CHARLES L. HUBBARD

In this article it is the purpose to show the general management of the special apparatus required in a system of forced hot-water heating, when used in connection with a power plant. For purposes of illustration, the plans of a system installed some years ago are given, as they embody a combination of steam- and water-heating apparatus not commonly found in the same plant. A brief description of the arrangement and operation of the plant will first be given, after which some of the details of design and the method of proportioning various parts of the system will be discussed.

The case taken as an illustration is that of a large institution heated and lighted from a central plant. The lighting plant consists of five direct-connected units, the current from which is carried to the different buildings through an underground tunnel. Heating in all of the buildings is effected by means of hot water, which is forced through a large circuit main by centrifugal pumps located in the boiler room. The water is heated partly by the exhaust steam from the lighting engines and partly by means of large horizontal tubular water-heating boilers of special construction. The general arrangement of the different parts of the equipment is shown in Fig. 1.

Water-heating Boilers

In Fig. 1 is shown the location of these boilers, and the details of the method of setting are given in Figs. 2 and 3. The

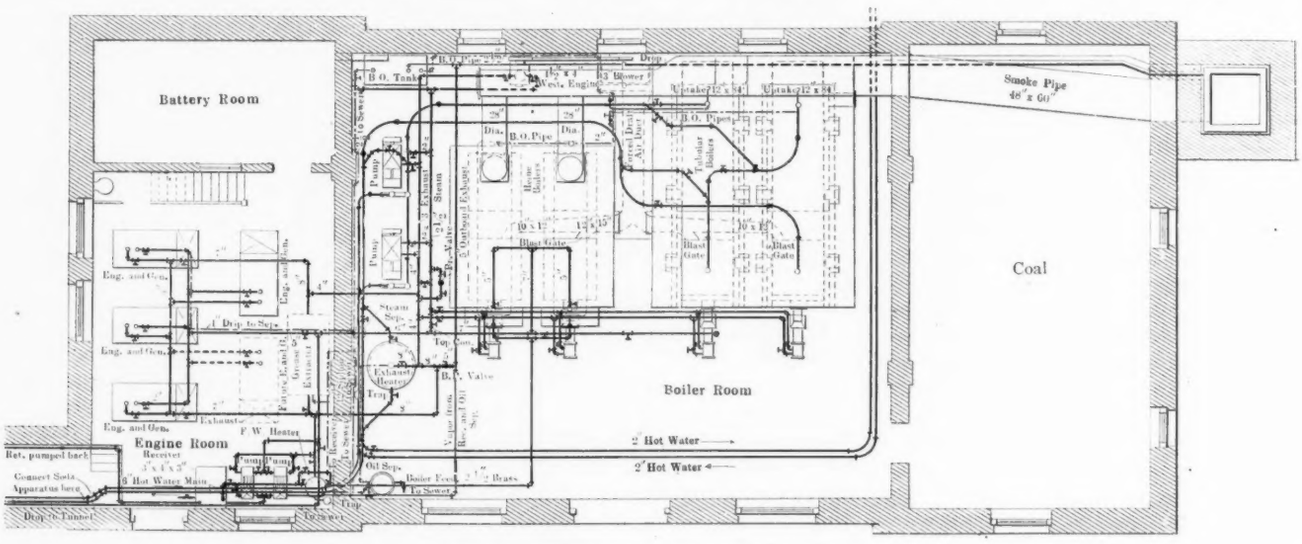


FIG. 1. GENERAL PLAN OF POWER PLANT

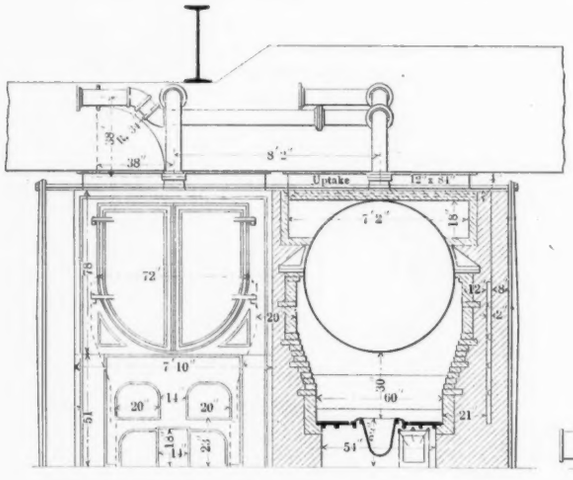


FIG. 2. SECTION AND FRONT ELEVATION OF TUBULAR BOILER

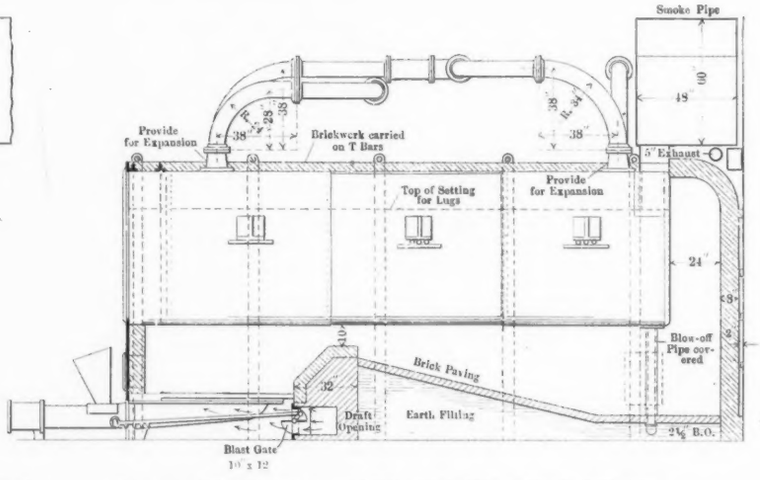


FIG. 3. LONGITUDINAL SECTION THROUGH BOILER SETTING

furnaces are equipped with mechanical stokers and forced draft, the air being delivered through the bridge-wall of the furnace by means of underground ducts. The blower and engine are shown in Fig. 1 at the rear of the boilers. In general construction the boilers are the same as for steam, except that no space is required

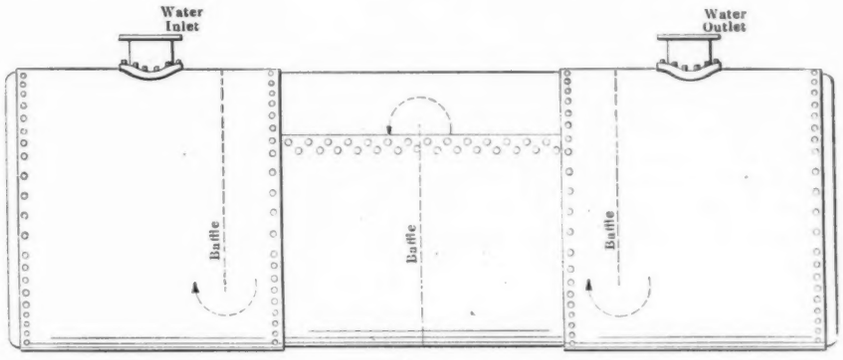


FIG. 4. BAFFLE PLATES TO PREVENT SHORT-CIRCUITING OF WATER

Steam Heater

Exhaust steam from the engines is utilized for water heating by means of the heater shown at the left in Fig. 7. Its location on the general plan, Fig. 1, is at the left and a little in front of the steam boilers. This heater has a hight of 12 feet, is 50 inches in diameter, and contains 163 two-inch tubes. As will be apparent from Fig. 8, the heater is of the closed type, the steam being on the inside of the tubes, while the water passes through the shell surrounding them. Here, as in the case of the boilers, baffle-plates are provided to prevent short-circuiting and to bring the water into contact with all

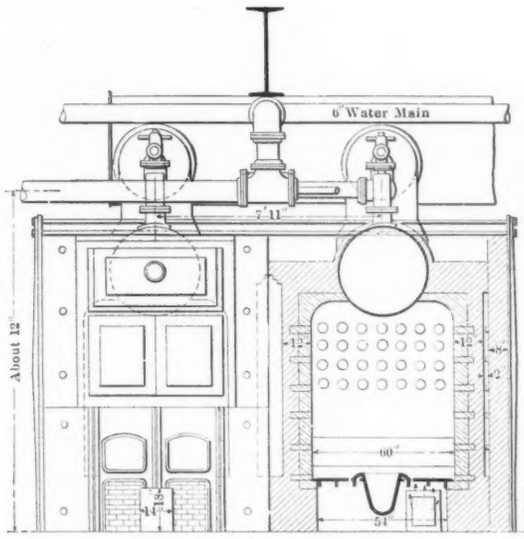


FIG. 5. HEINE BOILERS

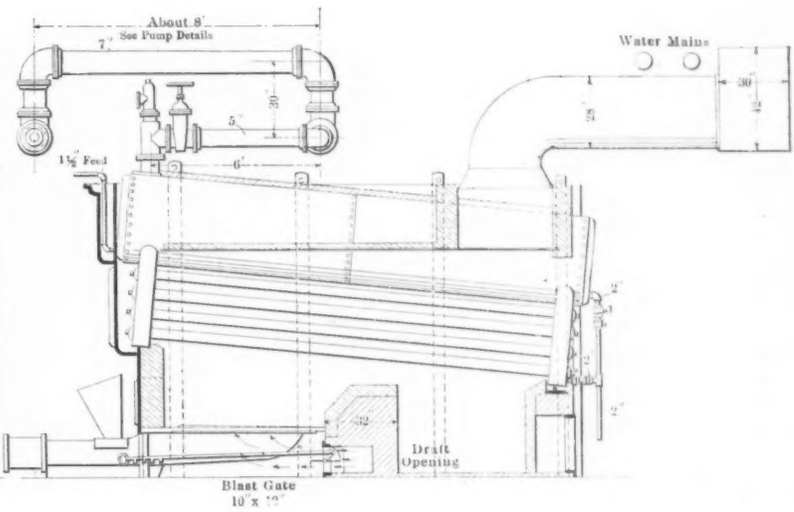


FIG. 6. SECTIONAL ELEVATION OF SETTING

above the water, and the whole shell is filled with tubes, thus doing away with the necessity of special stays or braces. The shells are 6 feet in diameter by 21 feet in length and contain 185 three-inch tubes. A special feature to which attention should be given is the arrangement of baffle-plates or deflectors, shown in Fig. 4. As the water is forced through the boilers at a comparatively high velocity, these are necessary to prevent short-circuiting between the nozzles.

The boilers are set with a return smoke flue over the tops, as shown in Fig 2, to utilize so far as possible the heat in the gases which first pass to the rear under the boilers, then forward through the tubes, and again to the rear over the tops of the shells, where they are taken off through metal uptakes to the stack.

Steam Boilers

Steam for driving the engines is furnished by a pair of water-tube boilers set just to the left of the heating boilers. These are provided with mechanical stokers and forced draft the same as the others. The general arrangement of settings and smoke connections is shown in Figs. 5 and 6.

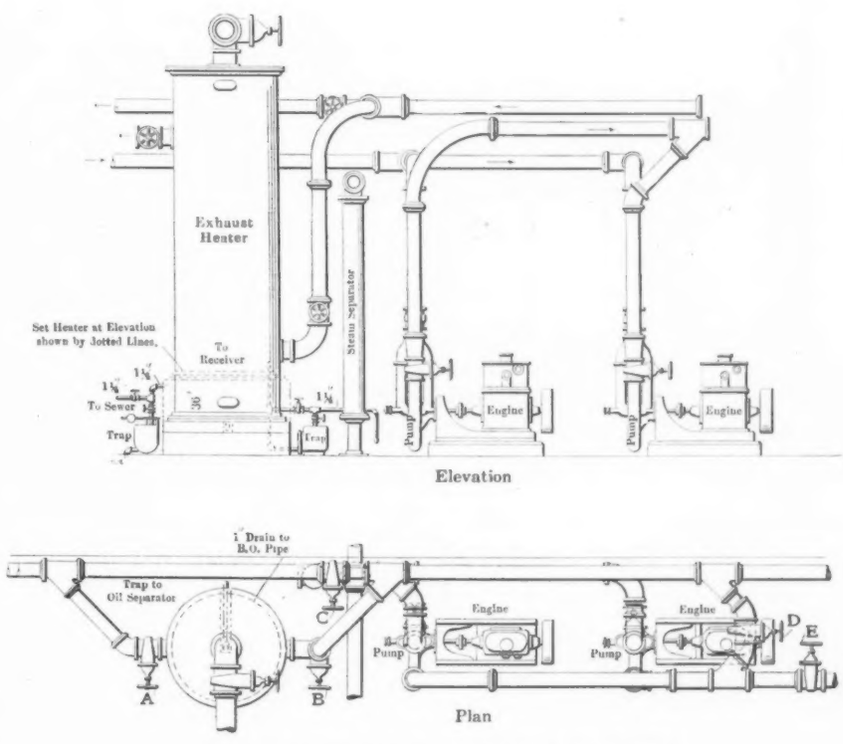


FIG. 7. PIPING OF EXHAUST HEATER AND PUMPS

parts of the heating surface. The heater is mounted upon a brick foundation at such an elevation as to drain properly, and steam is supplied through a single connection at the top. Circulation of the steam is produced by its condensation, which serves to lower the pressure and so produce a constant inward flow as fast as required.

The heater is air-vented near the bottom by means of a small hand-valve and also an automatic air-valve of large size. Water from the circulating pumps enters the side of the heater near the bottom and passes out on the opposite side near the top.

Oil Separator

From the exhaust heater the condensation flows into the trap, shown at the left in Fig. 7, and from there is discharged into the bottom of the settling tank, shown in Fig. 9. The oil which is contained in the condensation rises to the surface and may be made to overflow through the funnel by temporarily closing the valve between the tank and the main receiver of the boiler feed pumps.

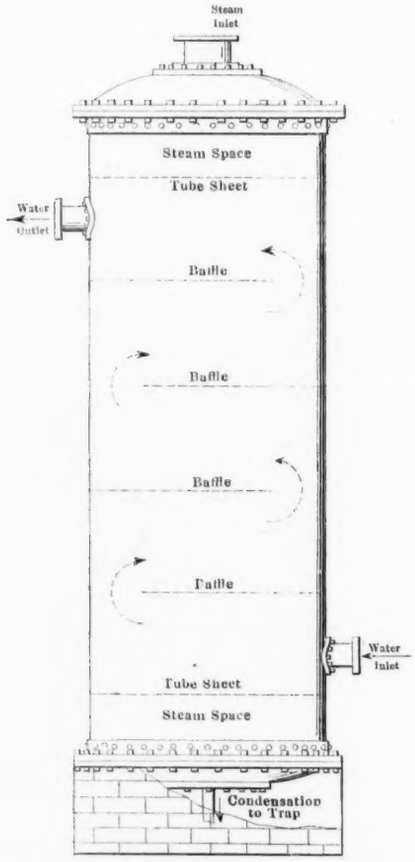


FIG. 8. CLOSED HEATER WITH BAFFLE PLATES

Under working conditions the normal water level in the tank and the receiver is the same, so that clear water flows from the bottom of the tank to the receiver by gravity at each discharge of the trap. A bypass to the sewer is provided above the trap for blowing out the heater under a low pressure.

Centrifugal Pumps

Water is circulated through the mains by means of two centrifugal pumps, each direct-connected to a high-speed vertical engine. These units are located at the side of the heater, and are shown in Figs. 1 and 7. Each pump is of sufficient capacity to perform the entire work, but is duplicated to provide against accident or repairs. As the operation of the entire heating plant depends upon the pumps, it is very important that every possibility of a breakdown be guarded against.

Ordinarily the pumps and engines would not be placed in the boiler room, but in the present case there were special reasons for doing this, and an inclosed engine was chosen especially with the idea of keep all bearing surfaces free from dust.

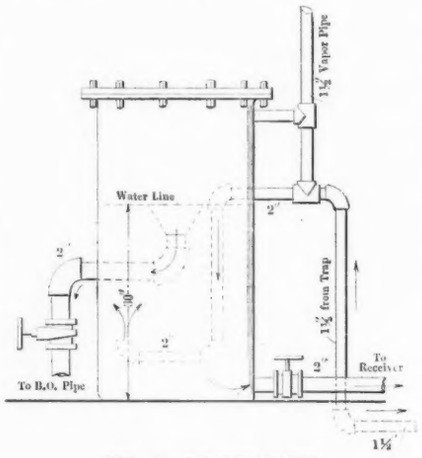


FIG. 9. OIL SEPARATOR

Heating Mains

In Fig. 1 the general arrangement of the hot-water heating mains is shown in heavy lines. The mains are so connected that the returns are brought directly to the suctions of the pumps; the pumps discharge into a main leading to the rear nozzles of the hot-water boilers. Connections are taken from the front nozzles which join the flow or supply main leading by way of the tunnel to the main buildings. Where this main passes back of the exhaust-steam heater, a bypass connection is made so that the water can also pass through the heater in series with the boilers. There is also a cross-connection so that the water, as it is discharged from the pumps, may be passed directly through the exhaust heater and on to the buildings without going through the heating boilers at all. The arrangements of the cross-connections and valves are best shown in Figs. 7 and 10.

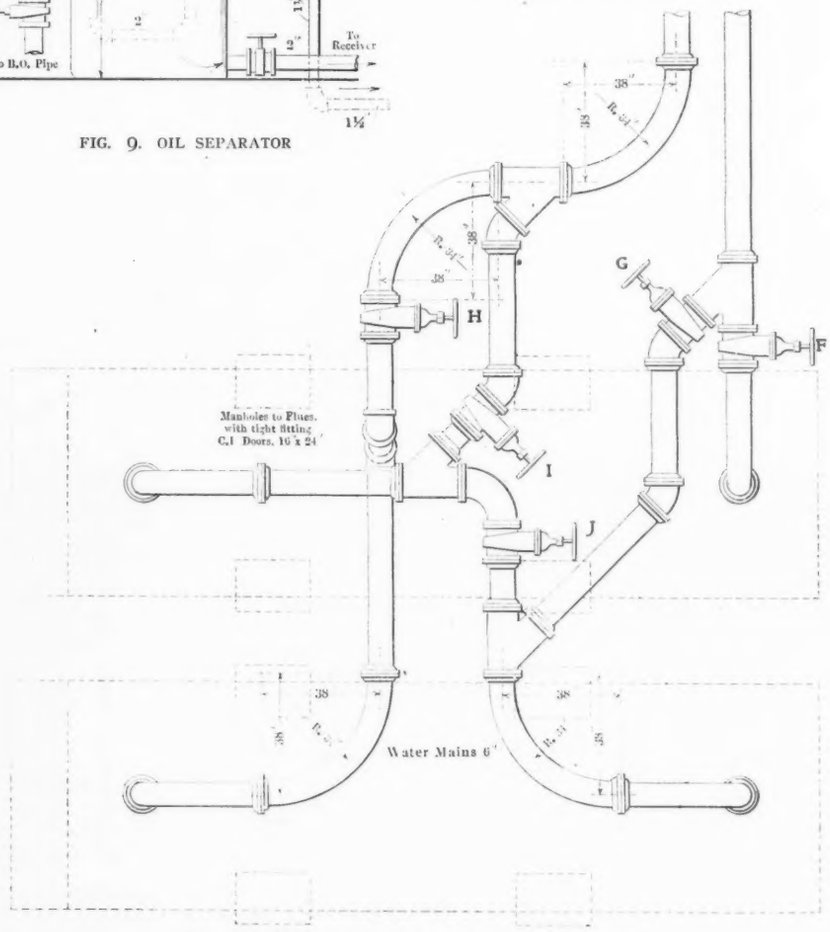


FIG. 10. PLAN OF PIPING OVER TUBULAR BOILERS

Referring to the piping plan in Fig. 7, it is evident that by closing valves *A*, *B* and *E* and opening *C* and *D*, the water may be sent from the pumps into the supply main without passing through either heater or boilers. Opening *A* and *B* and closing *C* sends the water through the steam heater; opening *E* and closing *D* sends the water first through the heating boilers and then through the steam heater

in series, or closing *A* and *B* and opening *C* cuts out the heater and throws the whole duty on the heating boilers.

From Fig. 10 it is evident that the boilers may be used in series by closing valves *G* and *I* and opening *F*, *J* and *H*, or they may be operated in parallel by closing *J* and opening *F*, *G*, *H* and *I*. Again, the valves may be so set that either boiler may be cut out and the other used alone, or in connection with the exhaust heater. Under ordinary conditions in mild weather sufficient heat is obtained from the exhaust steam; this failing to be sufficient, live steam is admitted at a reduced pressure through a regulating valve as needed to maintain a slight pressure

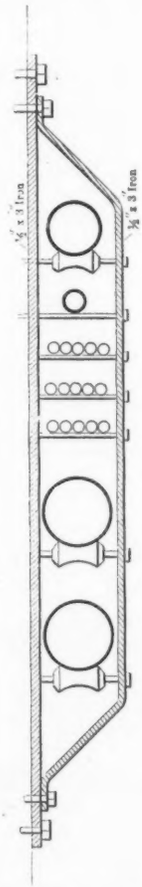


FIG. 11. PIPE AND CABLE SUPPORT

within the heater. As more heat is needed one or more of the large heating boilers can be thrown into the circuit as may be found necessary.

After leaving the power house the supply main makes a circuit or loop, passing through the basements of all the buildings, which are connected by tunnels. The method of supporting the various pipes and the electric cables is shown in Fig. 11. The racks are bolted at frequent intervals to the walls of the tunnels, or to the basement walls of the buildings themselves. Each building or section is connected with the supply and return mains, the difference in pressure or head between the two being sufficient to produce a positive circulation through the risers and radiators. This difference in pressure between

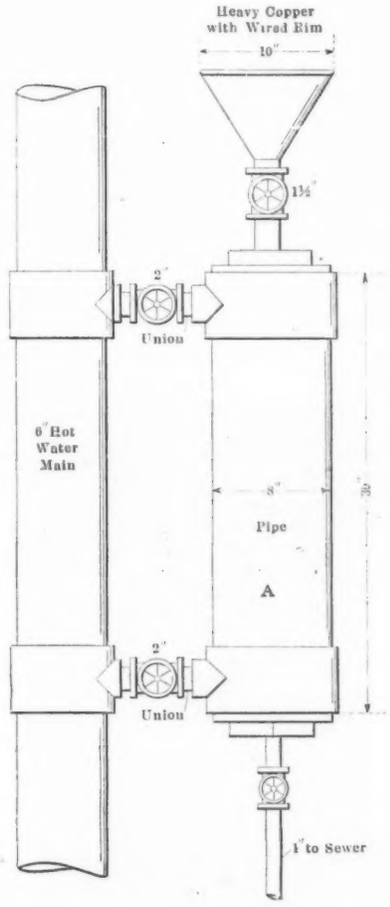


FIG. 12. APPARATUS FOR INTRODUCING SODA SOLUTION

the supply and return mains is, of course, greater nearer the pumps, hence it is necessary to throttle down the connections at this point and to gradually open the valves more and more along the line as the distance increases, in order to produce a uniform circulation through all parts of the system. Thermometers and pressure gages are connected into both the flow and return mains, so the conditions within the pipes may be determined along the line.

Fig. 12 shows a connection made with the supply main for introducing soda solutions into the water to prevent corrosion and incrustation in the heating boilers. When using, the chamber *A* is shut off from the main and drained through the drip-pipe at the bottom. It is then filled with the solution through the funnel at the top, and the side valves are opened, which causes the contents to be gradually carried into the water main.

The steam piping and the feed-water apparatus, etc., will be taken up in the next number.

Catechism of Electricity

733. *Show another arrangement of switchboard apparatus for a single-phase alternator.*

A small alternating-current installation is illustrated in Fig. 252. Here the switchboard apparatus is arranged somewhat differently from the equipment in Fig. 251. The alternator is shown at *c*, and the exciter at *d*. The switchboard

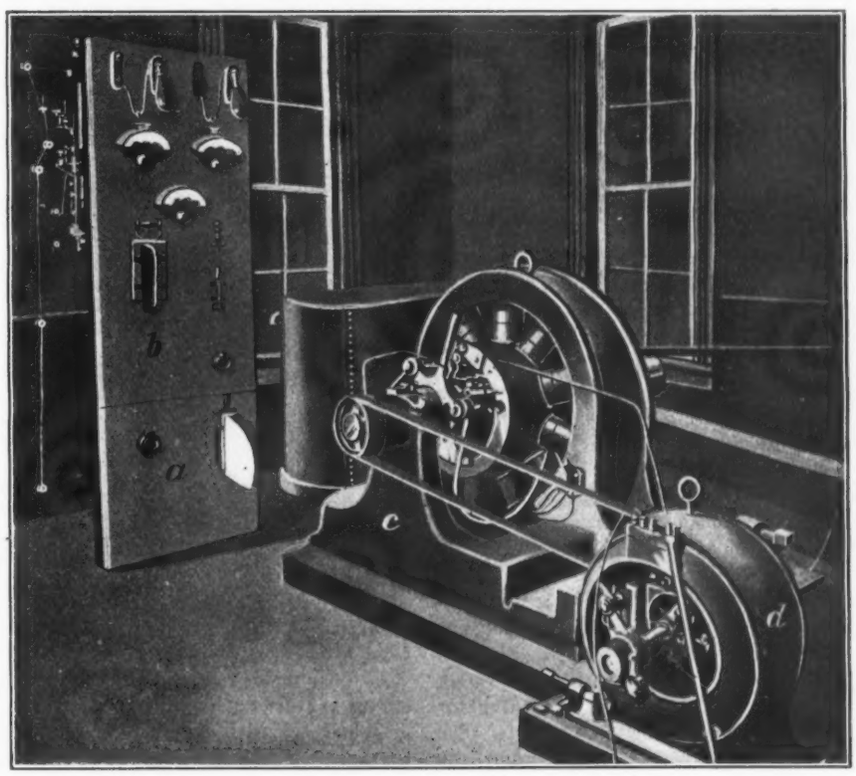


FIG. 252. A SMALL ALTERNATING-CURRENT INSTALLATION, SHOWING ARRANGEMENT OF ALTERNATOR, EXCITER AND SWITCHBOARD APPARATUS

consists of two slabs or panels *a* and *b*. The hand-wheel of the rheostat in the field circuit of the exciter is shown in the upper left-hand corner of the panel *a*, and the hand-wheel of the rheostat in the field circuit of the alternator is shown in the lower right-hand corner of the panel *b*. At the top of the board are the pilot lamps and fuses, and below these are an ammeter and a voltmeter connected to the alternator leads. At the center of the board is a direct-current ammeter connected in the field circuit of the alternator; this indicates the exciting current used. On the same panel, to the left, is located the main switch, and to the right a small double-pole switch which is connected in the field circuit of the alternator. On the lower panel is another switch; this is of the quick-break type and is used only in cases of emergency to open the main circuit of the alternator.

734. *What other arrangement of switchboard apparatus for single-phase operation is commonly employed?*

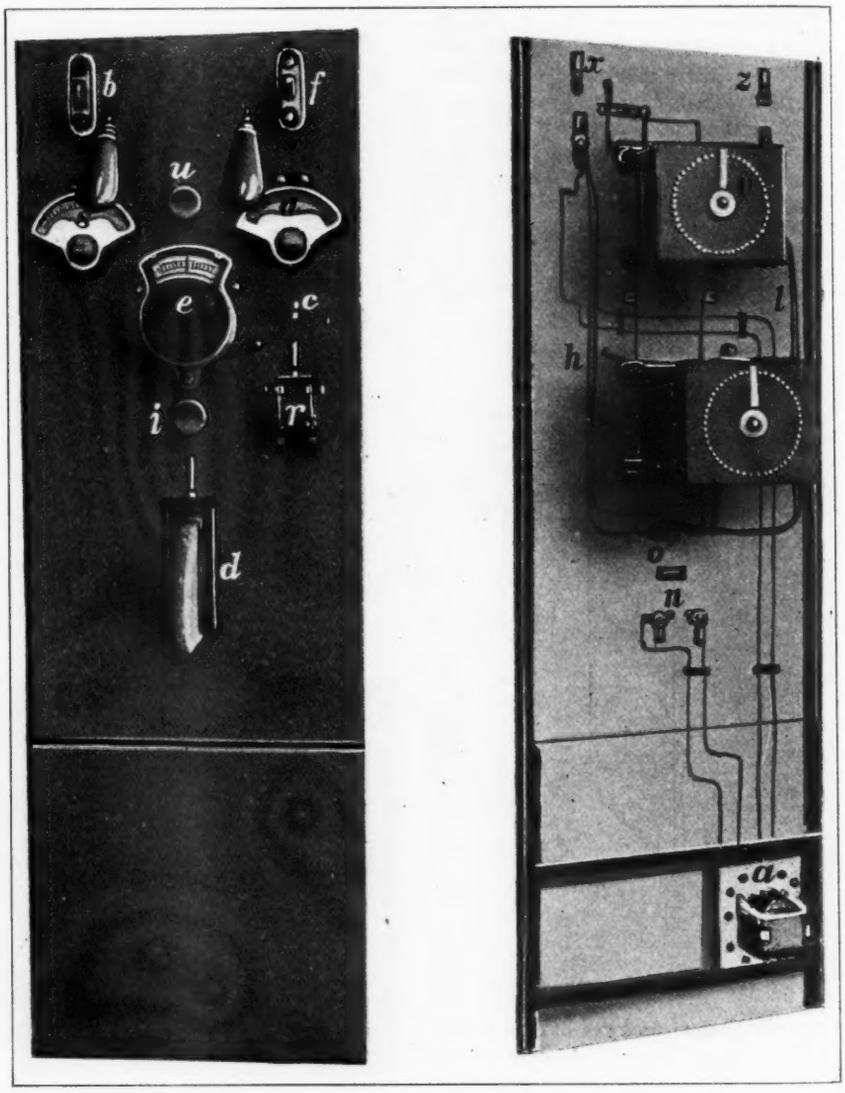
The arrangement shown in Figs. 253 and 254 is one frequently used in small plants. Fig. 253 shows the front equipment, and Fig. 254 the rear equipment of a single-phase switchboard panel. Here the exciting current of the alternator is not measured directly, but is ascertained approximately by the reading on the voltmeter *a*, Fig. 253, which is connected through the switch *c* to the step-down transformer, Fig. 254; this transformer is connected with the binding posts *n* which, in turn, are wired to the alternator mains.

735. *What are the other connections and instruments?*

The current from the alternator, passing to the binding posts *n* is led to those at *o* when the main switch *d* is closed, and passes thence through the ammeter *s*, and fuses *b* and *f*, Fig. 253, to the terminals *x* and *z* to which the outside circuit is connected. The ammeter *s* is wired in the main circuit *h l*, behind the exciter-field rheostat *v*, the hand-wheel of which is shown at *u*. The switch *r*, and the rheostat shown at *t* (hand-wheel at *i*) are in the alternator-field circuit. At *e* is a ground detector.

736. *How may a switchboard be wired for a three-phase alternator?*

In Figs. 255 and 256 are shown respectively front and rear views of a switchboard panel wired for a 2500-volt 130-ampere three-phase alternator. The three binding posts to which the wires from the alternator are connected are shown at *u*, Fig. 256. When the three-pole switch *c* (Fig. 255) is closed, the circuits are completed to the binding posts at *x*, Fig. 256, from which they run to the fuses *m*, *n* and *s*, the one wire being open at *v* for the admission of the ammeter *b*. The field rheostats of the exciter and the alternator are shown at *h* and *l* respectively, and the hand-wheels are shown at *c* and *r*. The switch *a* controls the field circuit of the alternator, and the direct-current ammeter *d* measures the exciting current in that circuit. When such an ammeter is used, the alternating-current voltmeter is mounted on a swinging bracket at the side; it therefore is not shown in Fig. 255 on the switchboard panel. The voltmeter switch is shown at *f*. Two electrostatic ground detectors, *x* and *z*, are placed on the board; also three lightning arresters *p*, *t*, *k*, and a step-down transformer *o* for use with the voltmeter. A rheostat *i* for service in compounding is also mounted on the panel, its hand-wheel being shown at *g*.



FIGS. 253 AND 254. FRONT AND REAR VIEWS OF A SWITCHBOARD PANEL EQUIPPED FOR A SINGLE-PHASE ALTERNATOR

737. *What advantage is gained by mounting the voltmeter on a swinging bracket?*

A swinging voltmeter is more convenient to the attendant when two or more machines are to be operated in multiple, because he can swing the voltmeter around so as to enable him to see the dial while throwing in any one of the generators.

738. *How is a swinging voltmeter bracket mounted on the switchboard?*

Fig. 257 shows a swinging voltmeter attached to a switchboard panel *m*. The swinging bracket *c* upon which the voltmeter *v* is mounted also contains a synchronism indicator *e*, and two synchronizing lamps *n* and *s*.

739. *How does the synchronism indicator work?*

The synchronizing indicator is of the dial type, and has a hand which revolves in one direction when the generator which is starting is running slower, and in the other direction when this generator is running faster, than synchronous speed. Synchronism is attained when the hand remains stationary at the zero mark, and the generator switch may then be closed. The two lamps are furnished as a check on the synchronizer. The connections to the synchronism indicator and lamps are made by inserting four-point plugs in receptacles which are provided on the generator panels. One plug must be in-

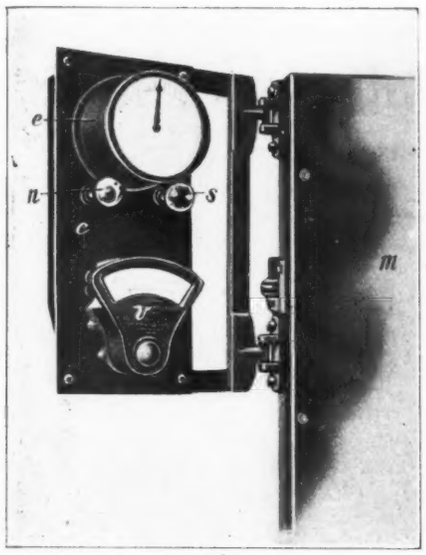


FIG. 257. SHOWING A SWINGING VOLTMETER ATTACHED TO A SWITCHBOARD PANEL

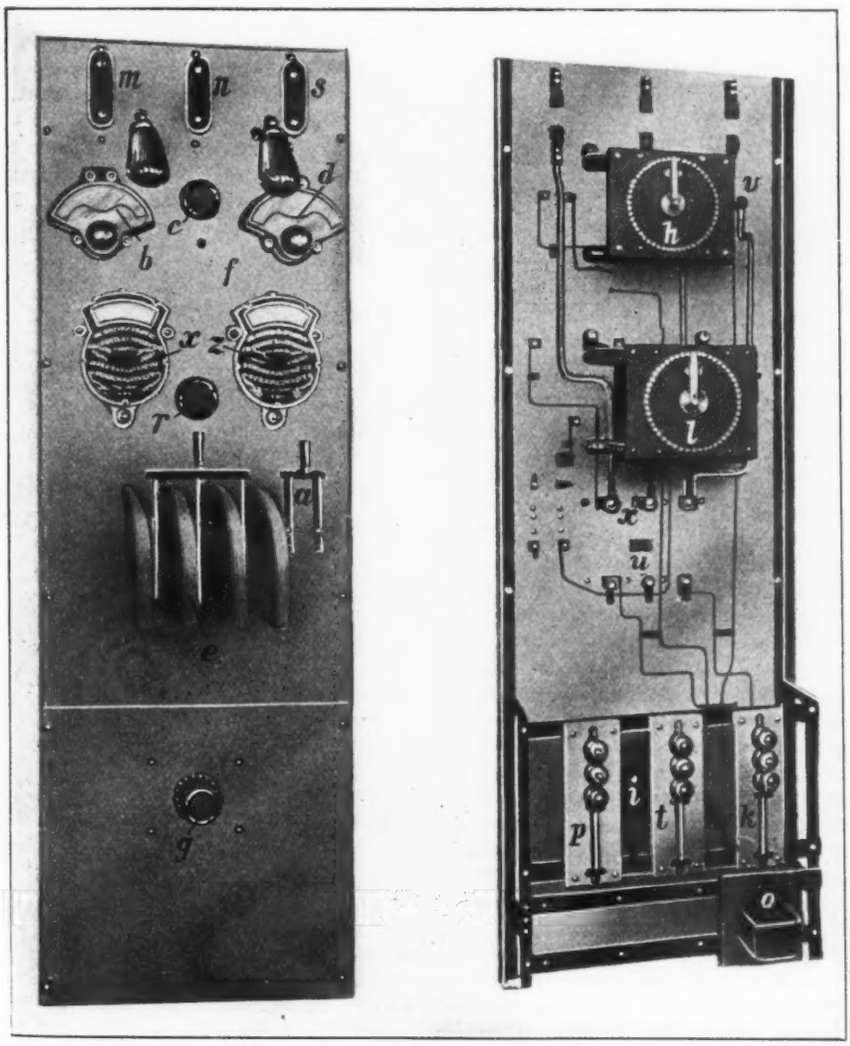
serted in the receptacle of the generator which is running, and another in the receptacle of the generator which is starting.

740. *Is it customary always to mount the lightning arresters on the switchboard as in Fig. 255?*

No; it is quite common practice to place them on the walls of the building near the point where the wires enter. When a small number of arresters are used, they should all be placed inside of the station, but with a large number they may be placed both inside and outside. In the latter case they must not, in any way, be exposed to moisture, but should be properly inclosed in an iron casing.

741. *Are any special precautions necessary in mounting lightning arresters on walls?*

When arresters are screwed to the wall they should be mounted on a sheet of asbestos. It is good practice to group all of them together and mount them on a separate board or panel of marble or slate. When marble or slate cannot be obtained, they may be mounted on a skeleton board, in which case they should be properly protected with sheet asbestos, and the board must not be placed near a wooden wall or any other part of the building.



FIGS. 255 AND 256. FRONT AND REAR VIEWS OF A SWITCHBOARD PANEL EQUIPPED FOR A THREE-PHASE ALTERNATOR

A World Record in Steam Power Efficiency

By F. E. Junge

That the manufacturers of high-grade steam engines have not been slow improving their products while gas power was making such forcible strides ahead, will be realized from the figures which Professor Gutermuth, of Darnstadt, reports of a Wolf "lokomobile." This is the name for a type of semi-stationary steam engines working with superheat (boilers and engines combined in one unit), which are manufactured in various sizes in the Wolf works in Magdeburg-Buckau. The engine tested had a capacity of 100 effective horse-power. The steam consumption per efficient horse-power was determined as 3.93 kilograms (8.6 pounds) and the coal consumption as 0.473 kilograms, or 1.04 pounds. Figuring on coal as costing $5 per ton in the particular locality, the fuel cost per horse-power comes out as low as 0.22 cent per hour. This is probably the best coal-consumption figure ever attained in the generation of steam power.

Annual Meeting of Congress of Inventors

The third annual meeting of the International Congress of Inventors was held August 4, when the following officers were elected for the ensuing year: President, Walter S. Strowger, Rochester; first vice-president, S. Feurstein, Rochester; second vice-president, Philip T. Dodge, New York; secretary-treasurer, Ralph T. Olcott, Rochester.

Plans are under way for active work during the fall and winter toward obtaining favorable action by Congress on bills which will be presented for the establishment of a standard for a United States patent, for the preservation of models, in the patent office, etc.

President C. C. Puffer, of the Pfaudler Company, of Rochester, urged the advisability of action in relation to Great Britain's new patent law, which requires that from August 28, one who obtains a patent in that country must manufacture under the patent in that country. It is argued that this will work a great hardship upon Americans. German patentees are also complaining and there may be, as a result, a German-American anti-English patent alliance.

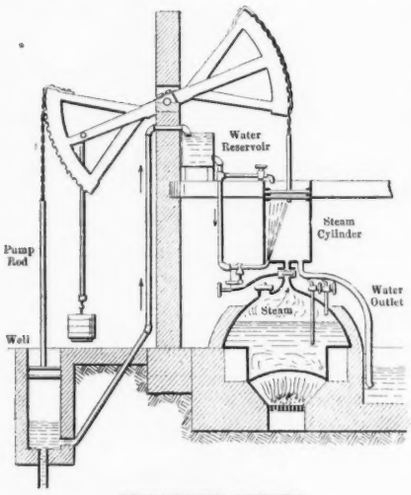
Try the safety valves frequently by carefully raising them from their seats. They sometimes stick. Care should, therefore, be exercised to keep them in good working order.

The Development of Non-Metallic Packings*

Early Forms of Packing; How Watt Overcame His Troubles with Packing; Classification of Packings; Objections to the Monkey Wrench Kind

BY W. E. SANDERS

When a stranger arrives in New York City and walks from the ferry to City Hall Square, he is impressed with the variety of means of conveyance. He sees omnibuses, horse-cars, elevated railroads,



NEWCOMEN ENGINE

trolley cars, and even finds a subway. In this he sees a condensed history of the problem of transporting business men to and from their work. When but few were to be carried, omnibuses and horse-cars were sufficient. As the number increased, elevated railroads and cable cars were added. But the pressure of the small army of business men seeking to get home demanded more and quicker conveyances and trolley cars and subways were built.

In looking over the various packings kept in stock in any large supply house a similar history will make itself apparent. Packings will be found that were used when steam pressures were low; better ones that were devised to meet higher pressures; still better ones that were designed to give satisfaction under high pressures, with but little friction, and lastly, packings to work with least friction under high pressures and superheated steam.

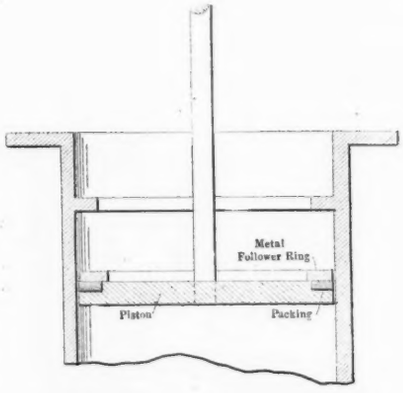
So the history of packing is closely allied with the history of boiler pressures and the use of steam. Therefore, beginning with the earliest engine and lowest boiler pressure, the development of packing and the principles of packing will be followed in this and subsequent articles from the simplest form to the most up-to-date packing now in use.

*Copyright, 1908, by W. E. Sanders.

Early Forms of Packing

James Watt is often called "The Inventor of the Steam Engine." He wasn't; but he did invent so many devices and improvements that he may rightly be called "The Father of the Steam Engine," even if strictly speaking only a stepfather.

James Watt had his troubles. In spite of ill health and financial struggles he learned a trade. He never served a regular apprenticeship and could not ply his trade within the precincts of the city of Glasgow. But under the cover of the University of Glasgow, which was free from the rule of the city, he was employed as an instrument maker. Here it was that he came across a model of a Newcomen engine, which he was to repair. This model belonged to the university. "Neces-



CYLINDER OF NEWCOMEN ENGINE

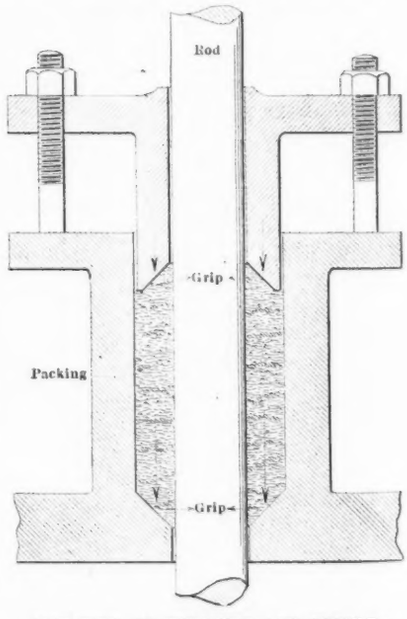
sity is the mother of invention," and the necessity of freeing the pits of the mines from water developed the Newcomen engine. Crude it seems when compared with the engines of today—a wooden walking beam strapped with iron and resting on the side wall of a building as a bridge. From the outer end hung a rod with a heavy weight attached, extending as the piston-rod of a force pump. When the rod was lifted, water was drawn into the pump. When it was lowered, the weight forced the water out of the pump and up to the surface of the ground.

On the end of the walking beam within the building was a wooden arc from which a rod was suspended by means of a chain. This arc and chain allowed the rod to move in line, and the rod was the piston-rod of the engine. The cylinder was open to the air at the top. At the bottom was an inlet for steam, another for injection water, and an outlet for the injection water and condensed steam.

The operation was simple and crude. The weight tilted the beam and lifted the piston. Steam was let into the cylinder. Water was then sprayed into the steam, and condensing it formed a vacuum. The pressure of the air on the piston forced it down, and in so doing tilted the beam and drew up the pump rod and weight and drew water into the pump. Then, when the outlet to the cylinder was opened and steam allowed to enter, the weight tilted the beam, thus drawing up the piston and at the same time forcing the water out of the pump. Startling as it may seem, there are many engines today in service which are working on the same principle.

Watt Had Packing Troubles

Did Watt have his packing troubles? He certainly did. He could not make that piston tight. There was no boring machine then. That was invented later by one of his foremen. Watt had to depend on imperfectly cast cylinders, and exults at one time because he had obtained a



DIRECTION OF PRESSURE AND RESULTANT GRIPS

cylinder that was within 3/8 inch of being true. What if you had a cylinder 3/8 inch greater in diameter one way than the other?

Watt cut a groove around the top of the piston and stuffed in cloth, rope, hemp and even straw, and on top of this placed

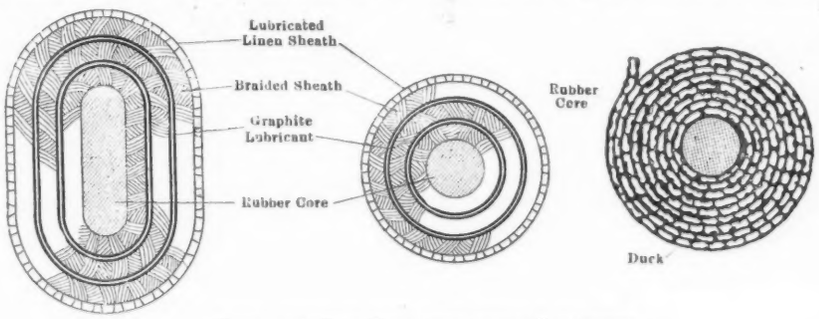
water. On this packing was often placed a ring of heavy metal intended to hold the packing in place. As there was no pressure from within outward, this packing served its purpose.

Watt was a man to overcome obstacles. His first difficulty was the inability of his boiler to supply enough steam. So he devised an outside jet condenser and thus saved the steam required to heat up the cylinder after each stroke. His next step forward was to place his cylinder horizontally and operate it from both ends, thus making it double-acting. This necessitated a stuffing-box, and the development of packing had begun.

As the first engines were really vacuum engines and used steam under practically no pressure, the problem at the start was an easy one. It was necessary only to prevent the air from rushing in, there being no pressure from within outward, and for this purpose the old rags, or rope, or waste soaked in oil would do very well. But when the boilers began to be better constructed and steam pressure from within came to be used, the stuffing-box developed and a gland was inserted to keep the packing from blowing out.

With the increase of pressure the problem of packing increases in difficulty, and it is well here to insert a table showing the average steam pressures during the past century:

	Lbs. per sq.in.
In 1800	from 0 to 5
In 1810	from 5 to 7
In 1820	from 5 to 10
In 1830	from 10 to 20
In 1840	from 15 to 20
In 1850	from 15 to 25
In 1860	from 20 to 30
In 1870	from 30 to 60
In 1880	from 60 to 90
In 1890	from 100 to 150
In 1900	from 125 to 200

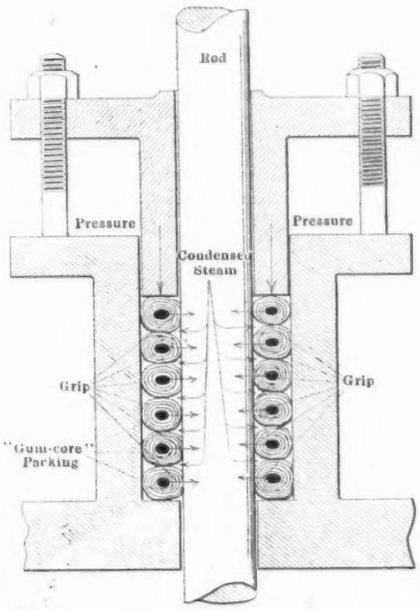


"GUM CORE" OR "RED CORE SPIRAL" PACKING

Classification of Packings

Packing is used to prevent any leak where two surfaces come together, behind the joint of which there is a pressure either of steam, air, ammonia, gas, water, oil, or other liquids or gases. There are two conditions. One is where the joint is made between two surfaces which are immovable, as where the ends of two pipes are joined together with a flange coupling, or where a valve-chest cover is placed on a valve-chest. This calls for the use of gaskets or sheet packing. The other condition is where one of two surfaces is movable, as is the case with the piston-rod or valve-stem of an engine, or the rod of a pump. Rod packings will be first considered and, afterward, sheet packings.

There is an almost numberless variety of packings, some good and some bad; all of them, however, can be classified into



OVAL PACKING TO INCREASE NUMBER OF GRIPS

certain groups, and these groups depend for their classification upon the pressure from within and upon the different principles used in the construction of the packing to restrain that pressure. These packings may be roughly classed as: Monkey-wrench packings, moisture packings, expansion packings, automatic packings, and packings for superheated steam or high temperatures. In this article the packing first named will be given attention.

Intensity of Grip and Points of Gripping

Before discussing these different packings it is best to see just what is necessary to hold back steam from following a moving rod. The best way to explain this is by illustration. To find the level of oil in a barrel a stick is run down through the bung-hole, and as it is brought out the oil will cling to it. The oil can be stripped off with the fingers, and if it is kerosene, this will be comparatively easy. If it is a good grade of machine oil, it will be more difficult, and the stick must be grasped more firmly with the fingers to strip off the oil. If the barrel contains a heavy cylinder oil or black oil, it will be necessary to exert a very tight grip, or else having stripped the oil off once, strip it again to complete the operation. In a rough way this illustrates what must be done to keep steam from following a rod out through the stuffing-box. If the pressure within is light, there is little tendency for steam to follow out, and a packing with but little grip will do the work. If the pressure from within is quite strong, it is necessary to grip the rod tightly, or else to grip it a number of times.

Of any packing designed to hold back pressure around a moving rod, whether the motion be reciprocating or rotary, the two necessary features are: The intensity of the grip or pressure on the rod, and the number of points of gripping. As the tightness of the grip is increased, the closer the packing is brought to the rod and the less the opportunity for the steam to follow the rod. To increase the number of grips on the rod increases the barriers to the steam.

Increasing the intensity of the grip is accomplished by using a monkey-wrench on the gland and screwing the gland down hard, thereby compressing the packing sidewise and producing a tight grip on the rod. The second end is accomplished by putting in a number of rings of packing so that there is one grip for each ring, or in other words, a number of grips upon the rod.

As today pressures range anywhere from zero or less to 250 or 300 pounds, or, in the case of hydraulic intensifiers, up to 4000 and 5000 pounds per square inch, it is evident that there will be used all forms of steam packing from the older and simpler makes up to the more modern and more desirable packings.

Monkey-wrench Packings

The first stuffing-box served only to hold the packing and prevent air from getting in to break the vacuum within. As steam pressures rose and a pressure from within was established, a gland with bolts and nuts was added to keep the packing from blowing out, and as pressures rose still further the gland was pressed in and the packing forced more tightly against the rod. The packing used was like yarn, and, being soft, a pressure from the gland squeezed it sidewise against the rod. This grip on the rod was amply sufficient for low pressures.

There came a time when this pressure was not enough. Steam would leak out, and to meet this exigency a change was made in the construction of the gland and

box. By beveling the gland and box, the pressure from the gland was turned at right angles directly against the rod, and an increased grip was obtained in two places in addition to that obtained in the old style of box. The box was beveled because it was cheaper to use a regular bevel-nosed drill than a special flat-nosed drill, and when a monkey-wrench packing was used, there was the advantage shown. For all other classes of packing a square-bottomed box is better, and it is generally a marked gain to make a beveled box square at the bottom.

Boiler makers now began to make stronger boilers and engine builders availed themselves of the increased pressures. The stuffing-box and its packing again proved inadequate. The box and gland could not be improved and attention was turned to the packing.

If you squeeze a sphere or a cylinder it is well known that it will flatten. With this in mind, packing was made in rings which were circular in cross-section. A pressure from the gland would squeeze them, causing them to spread out. This did not increase the intensity of the grip, but it did increase the number of grips, and gave rise to round or oval packing. To increase the effect a rubber core was introduced and added a spring or elasticity to the packing.

In addition, the spaces between the rings of packing served to hold moisture and entangle a small portion of the steam, which is a good point when the steam is moist; and even when dry steam is used, it becomes moist in the stuffing-box, which is naturally cooler than the cylinder.

These packings are known as "gum-core," or "red-core spiral" packing. The red-core spiral packing is made by wrapping around a red-rubber core a piece of frictioned duck cut on the bias, to give greater flexibility in bending it around the rod. The gum-core packings are made by braiding several sheaths about a round or a flat core. A flax or hemp twine is used in braiding, and each sheath is lubricated with graphite excepting the outer sheath, which is generally covered with a white, greasy lubricant. These packings are in use today to a very large extent, but they depend, as do all packings up to this point, upon the pressure from the gland.

Gum-core packing might possibly be expanded by the swelling of the core, but it is one case in ten thousand that it has a chance to do so. The red core has no more chance of expanding the duck about it than a hundred pounds of air pressure has to expand a ¾-inch air hose.

Monkey-wrench packings are so called because a monkey-wrench has to be used to make them efficient. The simplest form is the flax packing often used on the water end of pumps. The packing is placed in the stuffing-box fairly tight, and the moisture to some extent expands it, but if it leaks the engineer has recourse to a monkey-wrench to tighten up on the gland and increase the intensity of the grip. Any pump man knows that the packing can be squeezed in this way tight enough to short-stroke and even stop the pump. Think for a minute. If a pull of one pound is applied to the end of an 8-inch wrench to force a nut on a ¾-inch stud-bolt, a pressure of 80 pounds is exerted. There must be at least two stud-bolts, and this will mean 160 pounds pressure on the packing. It is then easy to understand why some pumps short-stroke and why pump-rods wear shoulders, especially if a cheap and poor form of packing is used.

This class of packing is open to a serious objection which may be illustrated by gripping a lead pencil with the thumb and forefinger of one hand and pulling it through the thumb and forefinger of the other hand. If the packing is forced too tightly against the rod it will be evident that a great deal of unnecessary work must be done by the steam, which means that more steam will be called for and ultimately more coal will be used, i.e., it is an expensive method. The effect may be observed by looking at an old pump-rod, and will be more noticeable here because the pump-rod is generally made of brass, which is softer than steel. The rods are often worn to a shoulder, and if they were put in a vise and filed down so as to get the same shoulder, the amount of work that had been done, and done at a loss, would be readily appreciated.

These packings then are the most uneconomical and most undesirable to use. They have, however, been used for years, and as old customs cling, they are still in use. The materials employed have been in quality poorer and poorer until now they represent about the cheapest form of packing.

A Small Railroad Plant

By P. A. Phelan

The installation of electro-pneumatic signals on railroads, as well as the extension of water facilities so that the locomotives may take water while in motion from track tanks, has necessitated the erection of various power houses along the systems to generate the necessary power to furnish compressed air, electric current and steam for such purposes. A recently installed plant of this character is found on the Pennsylvania system at Glenolden, Penn. This plant furnishes the power for pumping water to supply the locomotives passing this point, which average about 250 per day of 24 hours, as well as furnishing the compressed air and current to operate automatic signals a distance of about 15 miles on a four-track system.

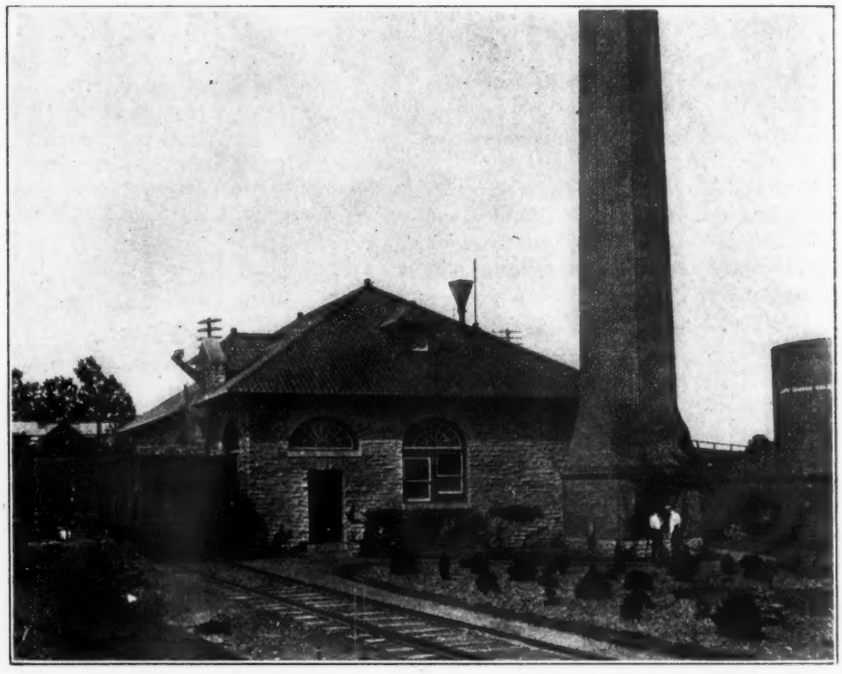


FIG. 1. AN EXTERIOR VIEW OF THE POWER PLANT

Building

The building housing this power plant is of neat design, being constructed of Leiperville granite throughout, with stone foundations, and covered with terra-cotta roofing tile supported on steel roof trusses. The exterior is surrounded by well-kept grounds in keeping with the adjacent properties, and large windows on all sides of the building secure exceptionally good ventilation and lighting. The building is 74 feet long by 45 feet wide, with a fire wall dividing the interior into a boiler room, 42x39 feet, and an engine room, 31x42 feet, inside dimensions. The floor of the engine room is on the ground level, while the boiler room is depressed 8 feet below this to

facilitate the handling of coal, which is dropped from the bottom of a gondola car into a specially prepared pit opening into the boiler room on the same level.

Boiler Room

The boiler room consists of two 60-inch diameter, 125-horse-power boilers of the locomotive type, with additional space for a future boiler. The boilers generate steam to supply the engines and air compressors, and in the winter furnish steam to heat the water in the track tanks. The stack, which is placed on the outside at the boiler-room end of the building, is built of red brick. It is octagonal in shape on the outside and has a circular flue 4 feet in diameter. The stack stands 75 feet high above a solid stone base, 10 feet square, and has a flue opening for the breeching 2 feet 5 inches wide by 5 feet 8 inches high.

For connecting the boilers with the stack a breeching of unusual construction was built up of 3/16-inch platen joined at the corners by 2x2x¼-inch angles. The flue is incased on top and sides by a 5-inch air space for insulation, and extends along the rear of the boilers and through the wall of the building into the stack, the flue connection between the building and stack being built of brick. All boilers are supplied with individual dampers. In addition to the boilers, there is in this room a No. 6 Cochrane feed-water heater of 350 horse-power capacity, as well as a 6x4x6-inch Fairbanks, Morse & Co. pot-valve pump, used for feeding the boilers, and Sellers injectors for emergency use.

A coal-storage space in front of the boilers and on a level with the floor has a capacity of about 70 tons, and is conveniently located for its purpose. Coal is delivered from the cars to this depressed storage space without the necessity of an elevated trestle. An interesting feature is the means provided for removing the ashes, which is done by an ash conveyer of novel type worked by air. It consists of a bucket traveling on a steel runway reaching from the ash pit below the boilers to a dormer in the roof and passing through to the outside so that the bucket may overhang the ash car and be automatically dumped. The pits under the boilers are large enough to hold quite an accumulation of ashes, which are kept until the coal car is empty, and are then raised in the ash hoist and dumped into the waiting car.

Another feature is the amount of head room above the boilers, there being 24 feet from the floor to the under side of the roof trusses. This permits of plenty of light and good ventilation, decreases the danger of fire on the roof and gives sufficient room for piping and for its repair and inspection.

Engine Room

This department contains two 11x12-inch automatic Skinner engines, direct-connected to 50-kilowatt, 500-volt Westinghouse generators, running at 280 revolutions per minute. These generators furnish current to the automatic signals and also to two motor-driven pumps located at the pump house about 1¼ miles distant. The current is transmitted by pole line to the pump house, which pumps the water to a stand-pipe of 376,000 gallons capacity located at the power house.

In the way of equipment there are also two Ingersoll-Sergeant air compressors,

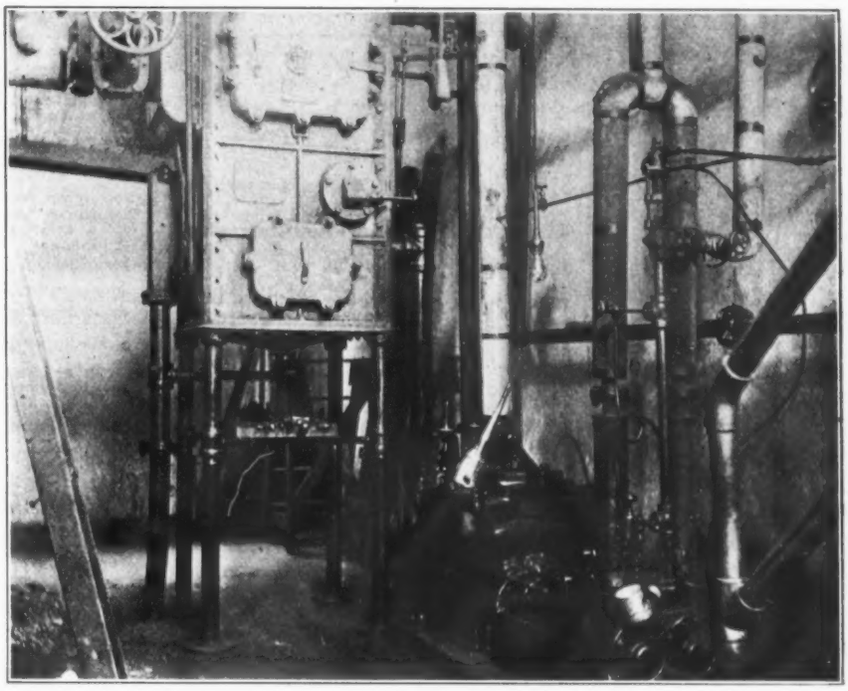


FIG. 4. COCHRANE HEATER AND BOILER FEED PUMP

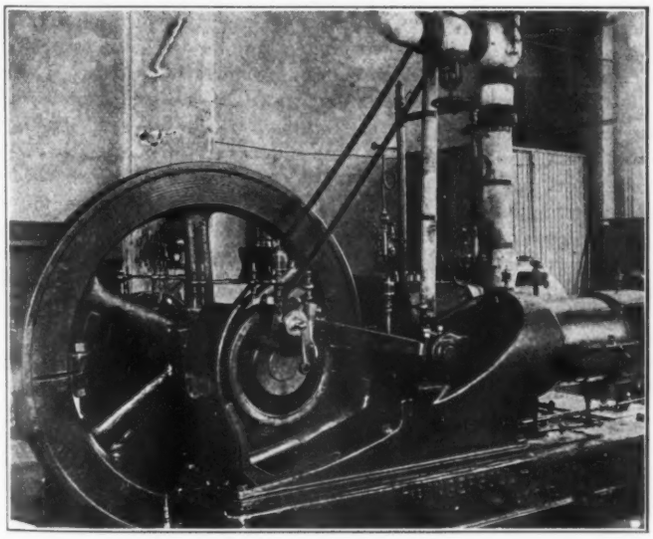


FIG. 2. ONE OF THE AIR COMPRESSORS

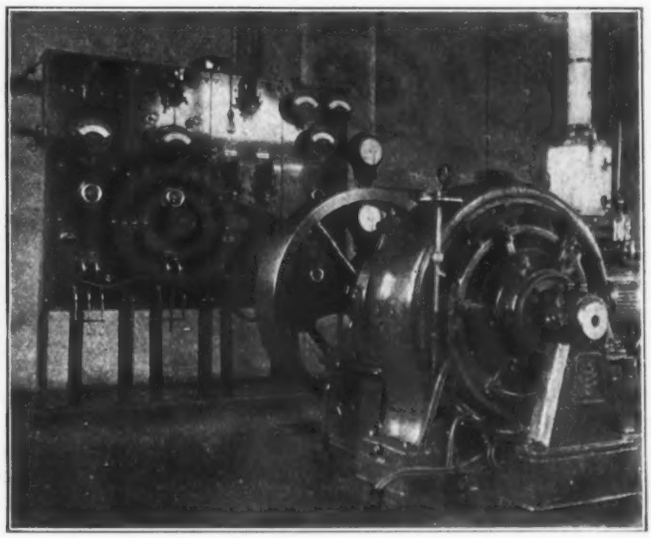


FIG. 3. GENERATING UNIT AND SWITCHBOARD

Class H, 12x20-inch compound steam and 18¼x12¼x12-inch compound air. Each compressor has a capacity of 513 cubic feet at a delivery pressure of 100 pounds; they are used to furnish air to the pneumatic signals on the road. In connection with the compressors is installed a water after-cooler in addition to the inter-cooler on the compressors. The after-cooler was designed by the railroad company and is necessitated by the special condition that the air to the automatic signals must be free of moisture, as a small amount of moisture in cold weather would cause trouble by freezing. There is also installed an atmospheric after-cooler outside the building to further cool the air; in non-freezing weather the atmospheric after-cooler only is used.

Piping

Steam from the boilers is delivered to a main steam header 8 inches in diameter, which runs directly through the center of the building and is supported from the roof trusses. 6-inch leaders make the connection from the boilers, and these are long-sweep, extra-heavy U-bends, rising up vertically from the boilers and entering the headers from the top. Each leader is provided with two valves. The steam lines to the engine and compressors are taken out of the side of the header and are dropped with a quarter bend into each unit. Cochrane separators are placed in each line. Live steam is also distributed to the track tanks for heating the water in winter.

All live-steam piping is of full weight wrought iron, with cast-iron flanges, screwed and peened. Chapman gate valves, outside screw, are used generally, and wherever possible bends are preferred to fittings. All fittings are extra heavy and flanged when 2½ inches and over.

From the main steam header drips are taken at each tee and through a trap are returned to the feed-water heater. The exhaust steam from the engines and compressors is also carried to the feed-water heater, which is located in the boiler room. The jacket water from the air compressors is first sent through the water after-cooler and thence to the feed-water heater. All live and exhaust steam as well as boiler-feed piping is covered with 85 per cent. magnesia.

The oil supply is stored in three oil tanks located in a concrete pit outside the engine room, and is forced up by air to the bib cocks in the engine room, where it is drawn off as required.

Keep the boiler clean internally. Do not allow scale, mud or oily matter to settle on the fire sheets, as it may cause the sheets to become burnt, bagged or buckled; also rupture, and explosion may result.

"Lusitania" Dimensions

Some of the principal dimensions of the turbines and boilers of the "Lusitania" are given in a paper recently presented to the Institution of Naval Engineers by Thomas Bell, as follows:

ENGINES.

Turbines.	Diameter of Rotor. In.	Length of Blades. In First Expansion. In.	Length of Blades. In Last Expansion. In.
H.P.	96	2⅜	12⅜
L.P.	140	8½	22
Astern	104	2¼	8

Total cooling surface, main condensers ..... 82,800 square feet
Area of exhaust inlet ..... 158 square feet
Bore of circulating discharge pipes ..... 32 inches

BOILERS.

Working pressure, 195 lb. per square inch.
23 double-ended boilers, 17 ft. 6 in. mean diameter by 22 ft. long.
2 single-ended boilers, 17 ft. 6 in. mean diameter by 11 ft. 4 in. long.

Total number of furnaces	192
Total grate surface	4048 square feet
Total heating surface	158,352 square feet
Total length of boiler-rooms	336 ft.
Total length of main and auxiliary engine rooms	149 ft. 8 in.

Regarding the forced lubrication system, the following gives the weights of the various revolving parts, together with the size of bearings and the pressure:

Weight of one H.P. turbine rotor complete	86 tons
Weight of one L.P. turbine rotor complete	120 tons
Weight of one astern turbine rotor complete	62 tons

	Main Bearing Journals. Diameter.	Effective Length.	Pressure Per Sq.In. of Bearing Surface.	At 190 Revs. Surface Speed of Journal.
H.P. rotor	27¼ in.	44⅞ in.	80 lb.	1350 ft. per min.
L.P. rotor	33¼ in.	56¼ in.	72 lb.	1650 ft. per min.
Astern rotor	24¼ in.	34⅜ in.	83 lb.	1200 ft. per min.

Failure of Copper Pipes in Marine Practice

The failure of copper pipes in marine practice has, with the advance in pressures of recent years, been a source of considerable anxiety to engineers and inspecting authorities in marine practice. In spite of every care and precaution failures have occurred, and it has not been possible in many cases to attribute these either to design or workmanship. Analysis of the failures has further shown that they have oftener occurred with seamless pipes that have been formed by electrolytic deposition on a mandril than with those made of sheet copper in the ordinary way. Tests of the material and subsequent analysis have as a rule only intensified the mystery. The copper has been shown to be particularly pure, and the pipes deposited in this way have complied very well with the stipulated mechanical tests. So well has this been recognized that many firms have discarded the use of electrolytically deposited pipes altogether. The trouble has been usually attributed to the absence in electrically deposited copper of the small amount of arsenic with which commercial copper is nearly always contaminated. The association between the impurity and the superior behavior of commercial copper pipes has, however, although generally accepted, not been identified with sufficient closeness to allow of the relationship being regarded as that of cause and effect, and some interesting notes on the subject made by J. T. Milton in his paper on "Copper Steam Pipes," before the Institution of Marine Engineers, shows pretty clearly that the generally accepted views on the subject are not correct.

The trouble from the use of such pipes is due to the fact that pure copper anneals at a lower temperature than when it is contaminated with impurities. This, from the researches of André Le Chatelier, is a result, it is well to note, that applies to all metals, the tendency of impurities, whatever their nature, being to retard the annealing, and the more pure the metal the more rapidly is the annealing effected. Curves given in Mr. Milton's paper show this very clearly. The influence of the time element in conjunction with the temperature is also interesting. Turning to the effect of temperature on ordinary commercial copper, M. Chatelier shows that when exposed to a temperature of 392 degrees Fahrenheit, which corresponds nearly to 180 pounds steam pressure, the copper is to some extent annealed, though full annealing with this metal does not occur until a red heat is reached—say about 1000 degrees Fahrenheit. Electrolytic copper, however, according to the authority quoted, is fully annealed at about 400 degrees Fahrenheit, and it is this property which renders it so unsuitable for the stresses to which steam pipes are subject in practice. These stresses are more or less localized according to the shape of the pipe and disposition of the range, and their effect is with an ordinary copper pipe to create hardness at that point, so that when the stress is next applied it is transmitted to some other part, and thus in a way gradually distributed more or less over the whole of the pipe, when, if the copper pipe is to fulfil its duty, it requires re-annealing. Now with electrolytic copper the pipes are practically annealed every time they are submitted to high-pressure steam, and the straining that takes place therefore always occurs at the same spot instead of, as with ordinary copper, being transmitted more or less over an area. The effect of this concentration of the strain at one spot, usually near the flange, is to cause the material at that part eventually to break down from fatigue, whereas with ordinary copper "the hardness created at the first yielding helps to spread the subsequent deformations over the remainder of the pipe."—*The Mechanical Engineer.*

Elementary Hydraulics for the Engineer

Graphical Presentation of the Principles Governing Flow, with Tables of Heads, Velocities and Coefficients of Discharge

BY FRANKLIN VAN WINKLE

Under most circumstances the measurement of a quantity of water can be determined by ascertaining the quantity discharged in a given time through some kind of a passageway or orifice, whose dimensions are ascertainable.

Quantity of Flow

If *A B C D E* in Fig. 1 represent a

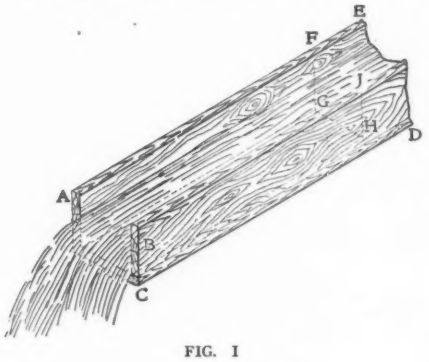


FIG. 1

trough through which water is flowing, so that every part of the steam passes the section *F G H J* at the rate of 8 feet per second, then the velocity is said to be 8 feet per second. If the stream of water is 2 feet deep by 3 feet wide, the cross-sectional area will be

$$2 \times 3 = 6$$

square feet. The volume flowing per second past *F G H I* will be

$$8 \times 6 = 48$$

cubic feet. If, instead of the velocity being uniform in all parts of the section passing *F G H J* the different parts of the section were traversed by the water at different velocities, then, if their average velocity equalled 8 feet per second, it is evident that the total volume flowing would be the same as in the former case.

A similar method of computation can be employed for determining the quantity discharged through any orifice, i. e., by multiplying together the area of the orifice and the average velocity of the stream, we may ascertain the volume discharged in a given time. For obtaining results, which are close enough for all practical purposes, the mathematical rules involved are few in number and easily applied, but to make proper application of those rules, one should be impressed with the principles of the theory of flow and the leading conditions which tend to modify the velocity of flow.

Flow is Produced by Unequal Pressure

Pressure on a liquid is transmitted through every particle of the entire mass, no matter what may be the extent of the body of the liquid. Therefore, any force which tends to destroy equilibrium among the particles of a body of water, tends to produce motion among all its particles. Natural flow is the motion produced by the force of gravity acting upon individual particles, each particle constantly moving from a place of greater head to a place of lesser head. The force of gravity is converted into pressure, and pressure into motion.

When an opening is made through the

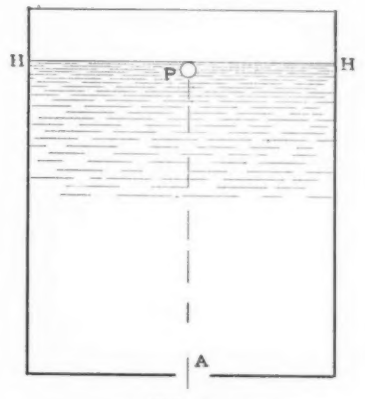


FIG. 2

bottom or side of a vessel containing water, the water is discharged by the unresisted force of gravity acting downward, which force is transmitted equally in all directions in the same horizontal layer of the liquid. It is, however, a matter of common observation that the water flows out with a greater velocity the higher the head of water above the aperture.

Liquid particles of water move over and pass each other with such ease that they may be regarded as devoid of friction. If an orifice is made in the bottom of a vessel as at *A*, Fig. 2, a liquid particle *P* at the surface *H H*, unobstructed by those beneath it and falling freely, would upon reaching *A* have the same velocity as any other body falling through the same hight. If the vessel has been kept filled to a given level, for instance by a stream of water running into the vessel sufficient to replace that which has escaped, the particles would follow one another with the same velocity. Since pressure is the same in all directions, water would issue from an opening in the side of the vessel with the same velocity, provided the head or depth were the same in both cases.

From various observations and experiments, Torricelli, in 1644, announced the following theorem: The theoretical velocity of flow of water from an orifice is the same as that which would be acquired by a body falling from rest in a vacuum, through a hight equal to the head of water on the orifice. A suggestion of the truth of this theorem is afforded by the following circumstance:

If a vessel like *A B C D*, Fig. 3, with an extended bottom *D E*, be kept filled to a constant hight *H H*, then, under favorable circumstances, jets of water like *G, J, K, L* issuing upward from orifices connected with various parts of the vessel will each attain nearly the same hight as the level *H H*. It may be considered that if it were not for friction on

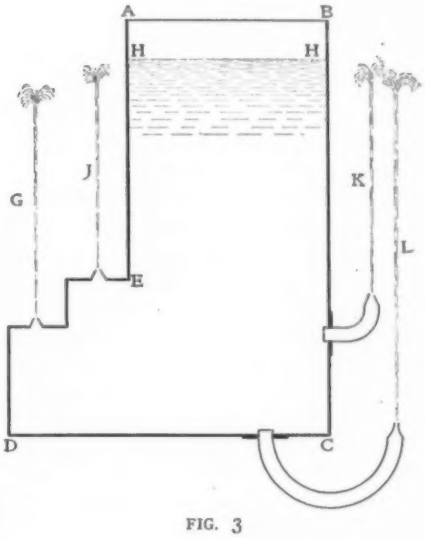


FIG. 3

the edges of the orifices and resistance offered by the air, each stream would actually reach the elevation of *H H*. According to the law of the conservation of energy, each particle of water as it is discharged from the vessel, should possess sufficient kinetic energy to rise to the hight *H H*. Since the velocity re-

quired to project a body upward to a given hight is the same as the body acquires in falling from a state of rest through that hight, the theoretical velocities at which the water issues from the orifice may be regarded as enunciated by Torricelli's theorem.

In calculating the theoretical velocity and theoretical discharge, the head is assumed to be measured from the center of the aperture in every instance, no matter whether the aperture is in a vertical side of the vessel, as shown in Fig. 4, or other sides or the bottom, as shown in Fig. 5.

Velocity Due to Gravity

The velocity of falling bodies is algebraically expressed by the formula:

$$V^2 = 2\,g\,h,$$

or as more commonly written

$$V = \sqrt{2\,g\,h}\ ,$$

in which g is the accelerating force of gravity and h is the hight. This formula and values depending upon it, are so generally used in the solution of hydraulic problems, that discussion of the flow of liquids would be incomplete without special reference to the derivation of the formula.

The force of gravity is perpetual. It not only acts on all particles of bodies when they are at rest, creating that downward pressure which is called weight, but also acts on them while falling, continually imparting new impulse and creating increase in their velocity. The rate of change of velocity of a body is called acceleration, and the acceleration of a falling body, due to gravity, is called the "acceleration of gravity." Gravity being constant, if unresisted it imparts to a falling body an uniformly increasing rate of speed.

It has been ascertained by experiment that a solid body falling freely in a vacuum at the level of the sea, drops through a hight of nearly 16.1 feet during the first second of time, has a velocity of 32.2 feet per second at the end of the first second, and during each succeeding second its velocity is accelerated 32.2 feet per second.

This rate of motion is slightly affected by change of latitude and elevation above sea level, but not enough to be taken into account in ordinary calculations.

If h = the hight or space through which a body falls,
t = the time in seconds,
g = the acceleration,
v = the final velocity in feet per second due to falling the hight h,

then

$$v = t\,g,$$

so that

$$= \frac{v}{g}. \qquad (1)$$

As the body starts with zero velocity, its average velocity will be one-half the final velocity, and as the total space or hight passed through will be the average

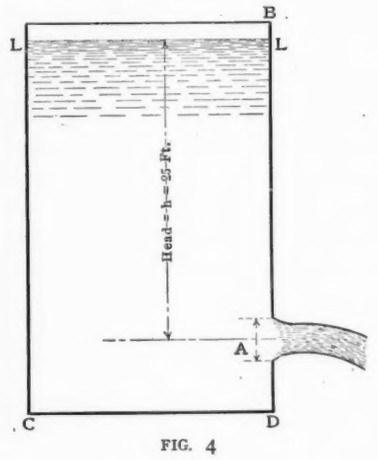


FIG. 4

velocity, multiplied by the total time, then

$$h = \tfrac{1}{2}\,v \times t, \qquad (2)$$

so that

$$t = \frac{h}{\tfrac{1}{2}\,v}. \qquad (3)$$

Making (1) and (3) equal to each other, we have

$$\frac{v}{g} = \frac{h}{\tfrac{1}{2}\,v}, \qquad (4)$$

from which

$$v^2 = 2\,g\,h, \qquad (5)$$

or

$$h = \frac{v^2}{2\,g}$$

and

$$v = \sqrt{2\,g\,h}\ . \qquad (6)$$

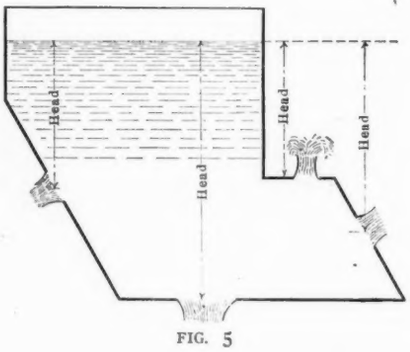


FIG. 5

As g in the above expressions always equals 32.2, the theoretical velocity v of flow in feet per second from the orifice, Fig. 4, due to the head h, may be written

$$v = 8.03\,\sqrt{h}\ ,$$

that is to say, the theoretical velocity in feet per second at which a liquid will flow from an aperture, may be found by multiplying the square root of the head in feet by the constant number 8.03.

TABLE 1. VELOCITIES DUE TO GIVEN HEADS.*

Head in Feet.	Theoretical Velocity in Feet Per Second.	Head in Feet.	Theoretical Velocity in Feet Per Second.	Head in Feet.	Theoretical Velocity in Feet Per Second.
0.01	0.80	2.6	12.9	24	39.3
0.02	1.13	2.7	13.2	25	40.1
0.03	1.39	2.8	13.4	26	40.9
0.04	1.60	2.9	13.7	27	41.7
0.05	1.79	3.0	13.9	28	42.5
0.06	1.97	3.1	14.1	29	43.2
0.07	2.12	3.2	14.3	30	43.9
0.08	2.27	3.3	14.5	31	44.7
0.09	2.41	3.4	14.8	32	45.4
0.10	2.54	3.5	15.0	33	46.1
0.20	3.59	3.6	15.2	34	46.7
0.30	4.39	3.7	15.4	35	47.4
0.40	5.07	3.8	15.6	36	48.1
0.5	5.67	3.9	15.8	37	48.8
0.6	6.22	4.0	16.0	38	49.5
0.7	6.71	5.0	17.9	39	51.1
0.8	7.18	6.0	19.7	40	50.7
0.9	7.61	7.0	21.2	41	51.3
1.0	8.03	8.0	22.7	42	52.0
1.1	8.41	9.0	24.1	43	52.6
1.2	8.79	10.0	25.4	44	53.2
1.3	9.15	11.0	26.6	45	53.8
1.4	9.49	12.0	27.8	46	54.4
1.5	9.83	13.0	28.9	47	55.0
1.6	10.2	14.0	30.0	48	55.6
1.7	10.5	15.0	31.1	49	56.2
1.8	10.8	16.0	32.1	50	56.7
1.9	11.1	17.0	33.1	60	62.1
2.0	11 4	18.0	34 0	70	67.1
2.1	11.7	19.0	35.0	80	71.8
2.2	11.9	20.0	35.9	90	76.1
2.3	12.2	21.0	36.8	100	80.3
2.4	12.4	22.0	37.6		
2.5	12.6	23.0	38.5		

* $v^2 = 2gh$.

TABLE 2. HEADS REQUIRED FOR DIFFERENT VELOCITIES.*

Theoretical Velocity in Feet Per Second.	Head in Feet.	Theoretical Velocity in Feet Per Second.	Head in Feet.	Theoretical Velocity in Feet Per Second.	Head in Feet.
0 25	0.0010	26	10.5	60	55.9
0.50	0.0039	27	11.3	61	57.8
0.75	0.0087	28	12.2	62	59.7
1.00	0.016	29	13.1	63	61.6
1.25	0.024	30	14.0	64	63.6
1.50	0.035	31	14.9	65	65.6
1.75	0.048	32	15.9	66	67.6
2.00	0 062	33	16.9	67	69.7
2.5	0.097	34	17.9	68	71.8
3.0	0.140	35	19.0	69	73.9
3.5	0.190	36	20.1	70	76.1
4.0	0.248	37	21.3	71	78.3
4.5	0.314	38	22.4	72	80.5
5	0 388	39	23.6	73	82.7
6	0.559	40	24.9	74	85.0
7	0.761	41	26.1	75	87.4
8	0 994	42	27.4	80	99.4
9	1.26	43	28.7	85	112.2
10	1.55	44	30.1	90	125.8
11	1.88	45	31.4	95	140.1
12	2.24	46	32.9	100	155.3
13	2.62	47	34.3	105	171.2
14	3.04	48	35.8	110	187.9
15	3.49	49	37.3	115	205.4
16	3.98	50	38.8	120	223.6
17	4.49	51	40.4	130	262.4
18	5.03	52	42.0	140	304.3
19	5.61	53	43.6	150	349.4
20	6.21	54	45.3	175	475.5
21	6.85	55	47.0	200	621
22	7.52	56	48.7	300	1397
23	8.21	57	50.4	400	2484
24	8.94	58	52.2	500	3882
25	9.71	59	54.1		

* $h = \frac{v^2}{2g}$

TABLE 3. COEFFICIENTS OF DISCHARGE FOR ROUND VERTICAL ORIFICES IN THIN PLATE ONE FOOT WIDE.

Head in Feet.	Diameter of Orifice in Feet.						
	0.02	0.04	0.07	0.10	0.2	0.6	1.0
0.6	0.65	0.63	0.62	0.61	0.60		
0.8	0.65	0.63	0.62	0.61	0.60	0.59	
1.0	0.64	0.62	0.61	0.61	0.60	0.59	
2.0	0.63	0.61	0.61	0.60	0.60	0.60	0.60
4.0	0.62	0.61	0.60	0.60	0.60	0.60	0.60
6.0	0.62	0.61	0.60	0.60	0 60	0.60	0.60
20.0	0.60	0 60	0.60	0.60	0.60	0.60	0.59
100.0	0.59	0.59	0.59	0.59	0.59	0.59	0.59

COEFFICIENTS OF DISCHARGE FOR SQUARE VERTICAL OPENINGS IN THIN PLATE.

Head in Feet.	Side of Square in Feet.						
	0.02	0.04	0.07	0.1	0.2	0.6	1.0
	0.66	0.64	0.62	0.62	0.61		
0.6	0.65	0.63	0.62	0.62	0.61	0.60	
0.8	0.65	0.63	0.62	0.61	0.61	0.60	0.60
1.0	0.64	0.62	0.61	0.61	0.61	0.60	0.60
2.0	0.63	0.61	0.61	0.61	0.61	0.60	0.60
4.0	0.62	0 61	0.61	0.61	0 60	0.60	0.60
6.0	0.61	0.60	0.60	0.60	0.60	0.60	0.60
20.0	0.60	0.60	0.60	0.60	0.60	0.60	0.60
100.0							

COEFFICIENTS OF DISCHARGE FOR RECTANGULAR VERTICAL ORIFICES IN THIN PLATE ONE FOOT WIDE.

Head in Feet.	Depth of Orifice in Feet.						
	0.125	0.25	0.50	0.75	1.0	1.5	2.0
	0.63	0.63	0.62	0.61			
0.6	0.63	0.63	0.62	0.61	0.61		
0.8	0.63	0.63	0.62	0.61	0.61	0.63	
1.0	0.63	0.63	0.62	0.61	0.61	0.62	0.63
2.0	0.62	0.62	0.61	0.61	0.61	0.61	0.62
4.0	0.62	0.62	0.61	0.60	0.60	0.61	0.61
6.0	0.61	0.60	0.60	0.60	0.60	0.60	0.60
10.0				0.60	0.60	0.60	0.60
20.0							

The theoretical discharge, i.e., the number of cubic feet which flows from the aperture per second, would be the theoretical velocity in feet per second multiplied by the area of the clear opening in square feet. The relations of head and velocity expressed in the formulas are so frequently referred to in problems which involve the flow of liquids, that to facilitate calculations, the theoretical velocities in feet per second due to different heads, and the heads corresponding to different theoretical velocities, are given in the accompanying tables, which have been computed from the formulas given.

As an example of the application of these tables, supposing *A B C D*, Fig. 4, to be a tank or other vessel containing water to the level *L L* and having in its side an aperture *A*, 2 feet high, 3 feet long and the top of the aperture 24 feet below the surface *L L*. It is required to find the theoretical discharge in cubic feet per second from the aperture.

The head acting on the center of the aperture would be

$$24 + 1 = 25$$

feet. From the table we find the theoretical velocity, due to 25 feet head, to be equal to 40.1 feet per second. The aperture being 2 feet × 3 feet, its area would be equal to 6 square feet; therefore, the theoretical discharge would be

40.1 × 6 = 240.6 cubic feet per second. The theoretical velocity and discharge from a simple aperture are, however, never fully realized.

ACTUAL VELOCITY AND DISCHARGE

When an aperture is made in the side or bottom of a vessel filled with water, the relief of pressure made by the opening tends to create motion of every particle towards the aperture, the velocity of each particle arriving at the aperture depending upon the pressure and its advantage of position. If the particles in passing out moved in parallel lines toward the aperture, as *L L L*, Fig. 6, and each filament delivered itself with a net pressure due to its head, then the theoretical velocity and discharge would be realized. The theoretical velocity is never realized because instead of the particles approaching the orifice in parallel lines, they may be observed to approach in converging paths, as indicated by the arrows *A B C* in Fig. 7, the effect of the particles which approach from the sides, like *A* and *C*, being to overcome the free egress of the others, like *B B*, which are striving to approach the orifice in paths which are more nearly parallel.

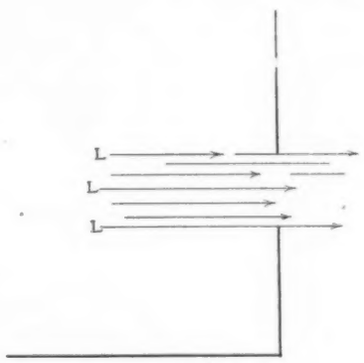


FIG. 6

If the aperture is made through a thin plate *A A*, or has sharp edges *B B*, as shown in Fig. 8, the issuing jet only touching the inner edges of the orifice along a line, the opening is called an "orifice in thin plate." The particles of water approach the orifice in converging paths, and continue so beyond the orifice until, as at *X Y*, they are parallel for a short distance, after which the jet has a tendency to increase in diameter. The smallest portion of the contracted vein, called the *vena contracta*, bears proportions to the dimension of the aperture *A A* and the distance *D*, which have been the subject of numerous measurements. For moderate-size round orifices with square edges, modern writers, following recent experiments, usually assign the following relative values: calling the diameter *A A* equal to 1, the distance *D* is taken to be 0.498 and the diameter of the contracted vein 0.7854. Taking the diameter of the orifice as 1, its area

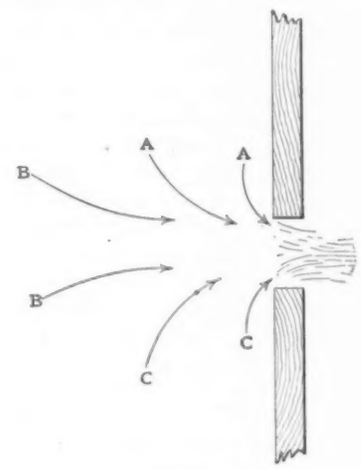


FIG. 7

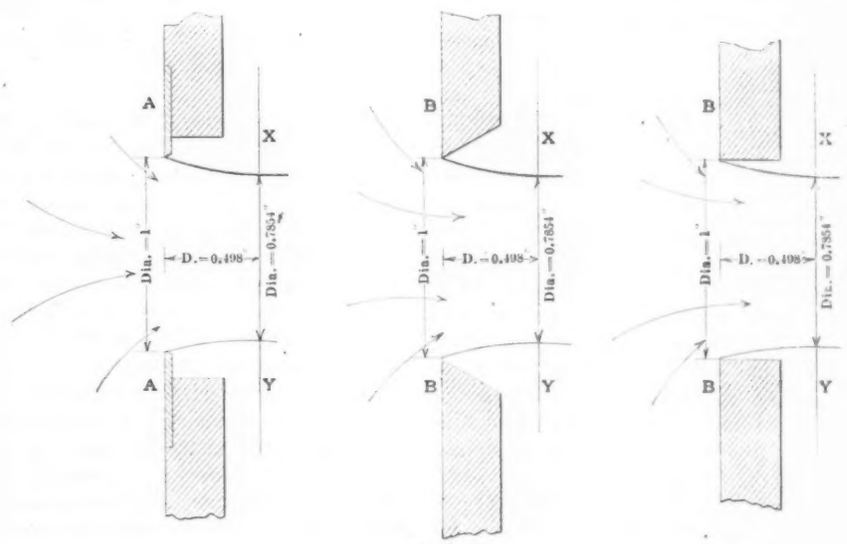


FIG. 8

would be 0.7854; and taking the diameter of the contracted vein as 0.7854, its area would be 0.484, i.e., the area of the contracted vein is 61.7 per cent. of the area of the aperture. This value is called the coefficient of contraction. It varies slightly in value for different forms of orifices and for the same orifice under different heads, but little is known of the extent of these variations or the laws that govern them. Carefully conducted experiments seem to indicate that the coefficient is smaller for circular orifices than for square ones, and smaller for square than for rectangular orifices, particularly if the rectangles are long in proportion to the width.

For all forms the coefficient of contraction appears to be less for high heads than for low ones, but for practical purposes the coefficient of contraction may be taken as 0.62. The velocity of the contracted vein cannot be measured directly, but knowing its size we can arrive at a value for its average velocity by comparing its size with the quantity discharged in a given time.

Coefficient of Discharge.

The coefficient of discharge is the number by which the theoretical discharge must be multiplied in order to obtain the actual discharge. The actual discharge of an aperture, in a given time, can be found by catching and weighing the quantity discharged, or by catching the flow in a vessel having vertical sides, the amount of water contained per unit of its depth being known. The latter method eliminates the consideration of density of the water due to its temperature.

Many thousands of experiments have been made to determine the actual discharge of apertures of different kinds discharging under different heads. The general form of apparatus employed for this purpose is shown in section in Fig. 9, in which *A B C D* represents a circular iron tank about 4 feet in diameter by 18 feet high, supported on cast-iron legs *L L*. Near the bottom *V* is a gun-metal flange into which interchangeable bushings with apertures, as *E F G*, may be screwed. The surface of the flange *V* is flat towards the inside of the tank, and the orifices of the bushings are small compared with the size of the tank, so that the discharge will not be materially influenced by the shape of the tank. After inserting a selected aperture, water is supplied to the tank by the supply pipe *P P*, which has branch pipes *p p* discharging against the inside of the tank to obviate currents. The approximate head in the tank above the center of the aperture is determined by the glass gage *G G*, and the head is regulated by the supply valve *S*, care being taken to keep the head uniform.

The head or level in the tank is most accurately determined by means of a hook gage *R H*, which consists of a rod with an iron hook at its lower end, the rod being laid off in divisions indicating the hight of the point of the hook above the center of the aperture *V*.

It is most convenient to measure the discharge by the depth to which it fills a vertically-sided vessel in a stated time, but in absence of such a receiving tank, very good results have been obtained by gathering the discharge into shallow receptacles and determining the quantity of water from the weight discharged.

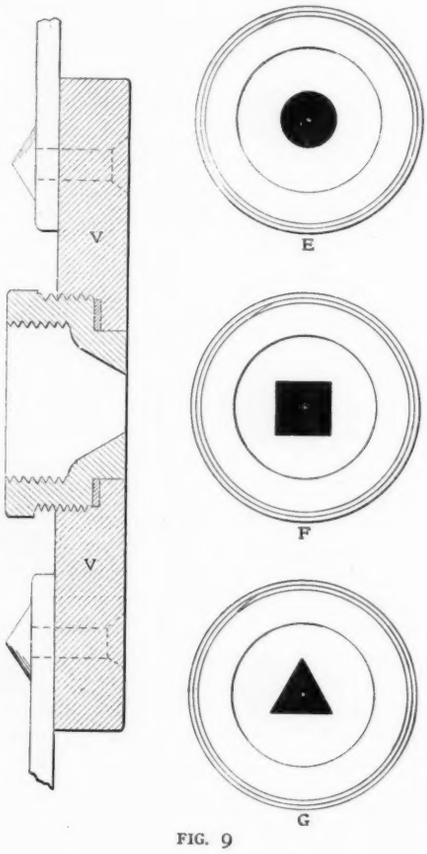
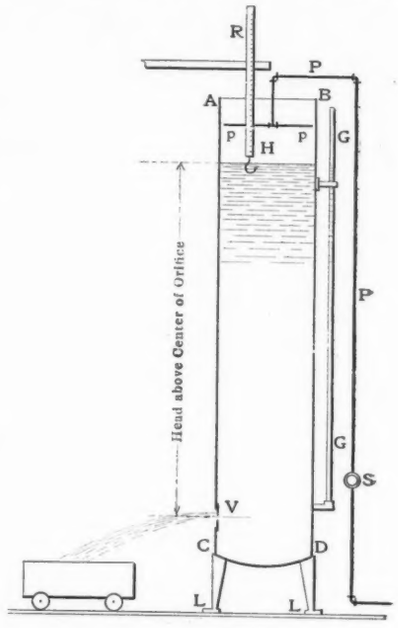


FIG. 9

As discharges are compared with theoretical discharges which would be obtained in cubic feet per second, it is customary to quote actual discharges in cubic feet per second, but in ascertaining actual discharges with any form of apparatus where accuracy is desired, the experiment should be continued over as long a period of time as is practicable in order to eliminate any errors of time in starting and stopping the tests. It might be stated here that inasmuch as theoretical velocities are quoted in feet and discharges are most conveniently reduced to cubic feet, it is best under all circumstances to quote the dimensions of aperture in feet and decimal parts of a foot.

To find the coefficient for any aperture, divide the actual discharge per second by the theoretical discharge, which would be obtained per second for the same size of aperture under the given head. As an example, suppose a square aperture in thin plate, 0.2x0.2 foot, under a 14-foot head to discharge 864 cubic feet of water in 20 minutes. In this case the discharge per second would be



$$\frac{864}{1200} = 0.72$$

cubic feet per second. The aperture being 0.2x0.2 foot, would have an area of 0.04 square foot. Turning to Table 1, we find the theoretical velocity would be 30 feet per second, so that the theoretical discharge would be $0.04 \times 30 = 1.20$ cubic feet per second. The coefficient of discharge would therefore be

$$\frac{0.72}{1.20 = 60}$$

per cent.

Tests made on different kinds of apertures show that different degrees of curvature of the edges of the orifice give different degrees of discharge. Orifices in thin plate have therefore come to be regarded as a kind of standard form of aperture for measurement of water, being adopted not only on account of greater exactness with which the form of the aperture can be specified, but also from facts proven by carefully conducted experiments, that the coefficient of discharge for different ordinary forms of orifices in thin plate vary but slightly when discharging under the same head, and more especially from the fact that for the same orifice under different heads, the coefficients are very nearly constant.

The closeness with which the coefficients of discharge of different apertures

agree with each other, as above, may be seen from inspection of Table 3, which gives coefficients of discharge for round, square and rectangular orifices in thin plate, of sizes and under heads approximating those most likely to be used together in practice.*

Inspection of this table will show that the coefficient in every case is greater for low heads than it is for higher heads, also that the coefficients for square orifices are larger than for round orifices and smaller than coefficients for rectangular orifices. It may be observed, also, that the average for orifices of all kinds is about 62 per cent. of the theoretical discharge, and that the use of a coefficient of 0.62 in the most extreme cases would not result in a greater error than 5 per cent.

We have already seen that the area of the most contracted part of the jet issuing from an aperture in thin plate is about 62 per cent. of the area of the aperture employed, from which it might be inferred that the velocity of the contracted vein is about the same as the theoretical velocity. Most careful measurements have shown, however, that the average velocity of the contracted vein is about 98 per cent. of the theoretical velocity due to the head. Still, for many practical purposes this small discrepancy can be neglected, and, knowing the area of the contracted vein and multiplying it by the theoretical velocity due to the head, we attain results for discharge which are very near to the truth. However, when the closest results attainable are desired, the discharge of the aperture employed should be previously ascertained, or else the coefficients of discharge should be used which have been determined under conditions of head, shape and size of aperture, all agreeing as nearly as possible with the circumstances under consideration.

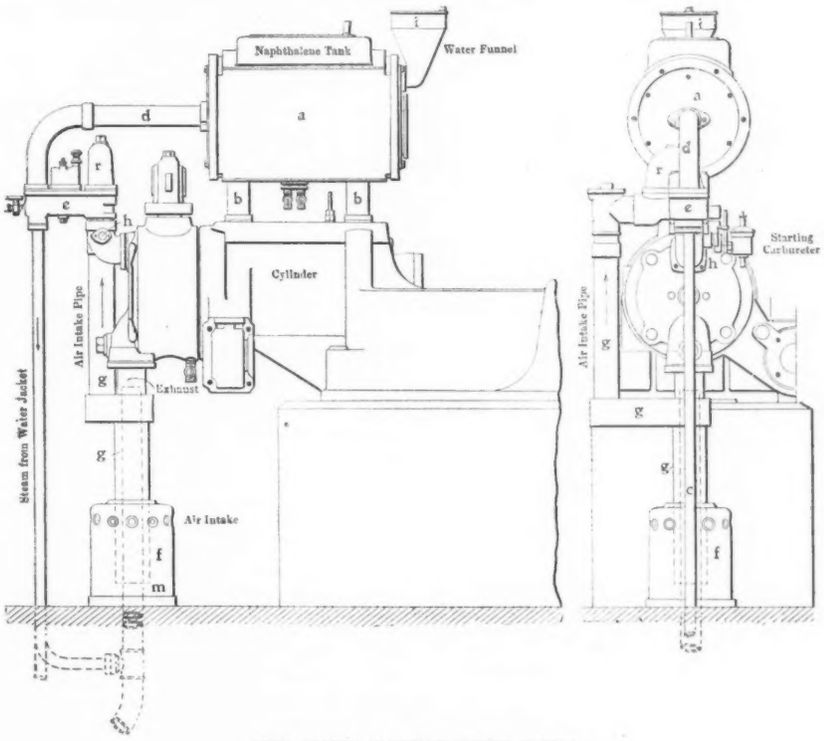
*The tabulation of round and square orifices is taken from tables of values determined by Hamilton Smith in a discussion of all of the best experiments on the subject, given in full in his book on "Hydraulics," (London and New York, 1886), and the table of coefficients of rectangular apertures has been compiled from a similar discussion by J. T. Fanning, given in his "Treatise on Hydraulic and Water Supply Engineering" (New York, 1899).

The Naphthalene Motor

By F. E. Junge

In a series of articles on the "Technical Aspects of Oil as Fuel,"* I have discussed the possibilities of using inferior and cheap grades of coal and coal-tar oils for power generation in liquid-fuel motors. The conclusion reached was that engines of the Diesel type were well fitted for using crude and paraffin oils, the cheapest kind of fuel available at that time, but that benzol, the modern substitute of gasolene, petroleum, alcohol, etc., and which is obtained in large quantities from the coal gas generated in retorts, coke ovens and producers, can be used only in engines of the explosive combustive combustion or Otto class.

*Power, October, 1907, to April, 1908.



THE DEUTZ NAPHTHALENE MOTOR

Among the various coal-tar products discussed attention was also called to naphthalene, a material which is solid at ordinary room temperatures but melts when heated beyond 79 degrees Centigrade. Up to a short while ago naphthalene had been used only for disinfecting and such purposes, and its price, owing to the small market available, was also low, namely, 8.5 pfennigs per kilogram, or 0.9 cent per pound, in Germany.

Lately the Deutz works of Cologne has perfected and put on the market a motor to burn raw naphthalene in a way which is indicated in the accompanying illustration. The fuel, which is sold in form of bricks, in order to be capable of gasification, must first be melted. This is done by charging, every two or three hours, a few bricks into the receptacle *a*, mounted on top of the engine cylinder; this is connected by pipes *b* with the water-jacket of the engine, and the water is kept boiling by the heat of the cylinder wall. The loss by evaporation can be made up through funnel *i*, as necessary.

The naphthalene bricks are contained in a separate vessel within the water tank, and are melted by the surrounding hot water, the liquid being kept at a fairly constant temperature — at least more so than would be possible by using exhaust gases for preheating the fuel. Excessive heating must be avoided, since it is apt to spoil the effect. The pipe *d*, which serves to conduct the water vapor to the carbureter *e*, is surrounded by a copper jacket which carries the liquefied napthalene to the carbureter; the latter is provided with a regulating float and spraying nozzle, arranged in the ordinary fashion. The carbureter is also heated by the steam from the water-jacket. The combustion air which enters through air admission pipe *r* into the carbureter, is preheated by the exhaust gases, in a manner indicated at the intake *f* and *g*. This is necessary in order to prevent cooling and condensation of the naphthalene vapor, which would result in clogging up the small openings of the nozzle.

If there is no initial source of heat available, the engine must be run on benzol or gasolene until the jacket water has become hot enough to melt the solid naphthalene fuel, which requires about half an hour. A second carbureter, mounted on the intake at *h*, is provided for starting purposes. The fuel consumption of the Deutz naphthalene motor of 10 horse-power is about 0.3 kilogram or 0.66 pound per effective horse-power-hour. Figuring on the price quoted above, the fuel cost per effective horse-power-hour is only 0.60 cent, against 2.7 cents with gasolene, 1.5 cents with benzol, 1.4 cents with petroleum, 1.8 cents with alcohol and 0.66 cent with crude oil, with motors of like capacity and with prices as obtain in Germany.

Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

A High Speed Bearing

For a bearing 3 inches wide, take a piece of copper ⅛ inch thick, 3 inches long and about ⅛ inch wider than the half circumference of the shaft that is to be run in the bearing. Thus, for a shaft 1½ inches in diameter, the circumference of which is 4.71 inches, the piece of copper may be 2.5 inches wide. Lay off and drill a number of ⅛-inch holes, as shown in Fig. 1, spacing them ½ inch apart, and countersink them well. Next bend the copper to a half circle, as in Fig. 2, on the shaft, using a heavy wooden mallet and being careful to see that the copper plate fits the shaft as closely as possible, with the countersunk side inside. Hang it in the bearing where it is to run, and after heating all the parts thoroughly, in order that the metal will run well without getting chilled, proceed to fill in with good babbitt metal, as shown in Fig. 3. Where the copper stands somewhat higher than the bearing, as at *X X*, it must be trimmed down flush with the top of the box. Then bolt the cap on in place, screwing it a little tighter than necessary, and run it for about a minute at full speed, without any oil; this will show where the high spots are. Scrape them until a perfect bearing is secured, and the bearing is complete.

Bolt everything in place, as in Fig. 4. The upper cap is provided with an ordinary babbitt-metal sleeve, or liner, shown at *B*, which has the usual oil channels cut in it, the lower one requiring no channels. No oil is used in this bearing, there being a grease cup provided in place of the usual oil cup, thus making it far more cleanly, and needing less attention. The grease does not spatter and fly off the shaft nor run down upon the floor. This bearing can be run at any speed up to five or six thousand revolutions per minute, or in fact can be used upon any woodworking machinery, or any kind of a high-speed machine, with less wear than where the ordinary kind of a plain babbitt bearing is used.

The latter generally require to be renewed two or three times a year, or perhaps oftener, according to the circumstances, whereas the kind just described has been in use for about two years, the only attention required being an occasional tightening of the cap.

GEORGE W. HAVLIN.

Cincinnati, O.

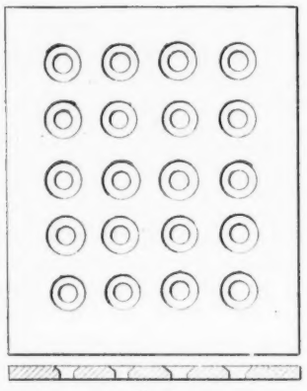


FIG. 1

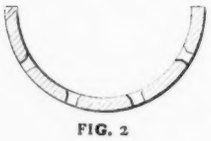


FIG. 2

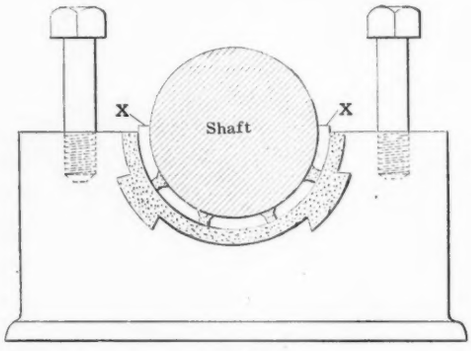


FIG. 3

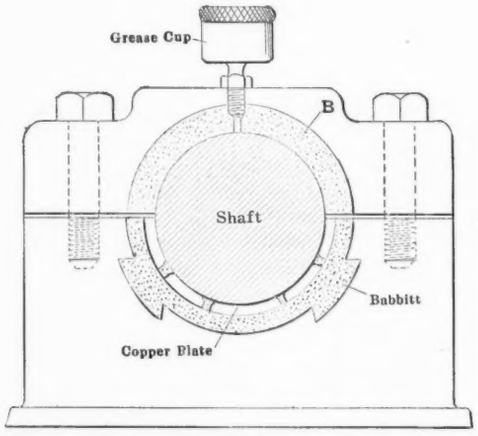


FIG. 4

Nominal and Actual Size of Shafting

In the June 23 number, on page 990, Matthew English asks what is the American practice about sizes of shafting; namely, is it the regular practice in America to have shafting 1/16 inch less than called for? By referring to catalogs of machinery supply houses it will be noticed that stock shaft boxes, hangers, couplings, etc., run 1/16 under size. Now as to shafting itself, Strelinger's catalog tells the story nicely: "Not so many years ago, before the days of cold-rolled and hot-polished shafting, all shafting was turned. In those days the rough bar iron was rolled from 1/32 to 1/16 oversize and shafting was turned down from bar iron. A 2-inch bar would turn down nicely to $1\frac{15}{16}$, and other sizes in similar proportions. The rough bars were usually not kept in stock in the larger sizes (say from 1½-inch upward) in less than ¼-inch variations, so that if an exact size, say 2½-inch, was required, it would be necessary to use the 2¾-inch rough stock, making the shaft cost considerably extra, both in material and labor. With the new process it is, of course, a simple matter to make a shaft of any exact size, but by common consent the old standard of sizes has never been changed, although we occasionally find a critic of the 'higher school' who tries to revolutionize the good old practice by insisting upon having 'exact' sizes, but who only succeeds in making a lot of work and expense, without doing himself or others any good. However, in connection with the foregoing, we deem it best to state that we fill orders as *specified*, and an order for 2-inch

shafting would be filled with shafting measuring *exactly two inches in diameter,* which would, of course, be 1/16 of an inch too large to fit the hangers and other fixtures carried in stock."

That is as good an explanation as I have ever seen as the reason shafting is taken 1/16 inch under size.

P. R. VAN FRANK, JR.

Memphis, Tenn.

The Thermostat

I believe that a simple, readable description of this instrument will be welcomed by many engineers. The articles that have hitherto appeared on this subject have seemed to be unnecessarily incumbered with detail. A man gets drowsy trying to dig out the principle, and those who have called on the makers for information have not been brilliantly successful in their quest. Why? Search me. It seems to me to be a very short-sighted business policy. However, the instrument in use in the Chicago public schools is most admirable and efficient. One must admire the inventor and his fine solution of the problem. The "Straight Air" instrument is referred to. The problem which confronted the lucky inventor was something like this:

If given a sufficient quantity of hot and cold air under pressure, to regulate its admission to a room in such a manner as to maintain a constant temperature.

The constant volume, or mixing damper *M*, Fig. 1, had already been evolved, together with its compressed-air actuated diaphragm *A*. Now, by stationing an attendant in the room to be regulated, it would be possible for him to operate the compressed-air valves *C* and *E*, and by opening and closing them at proper intervals, regulate the temperature to a satisfactory degree.

The instrument to be designed must displace this attendant; be powerful enough to operate the valve; operate by compressed air only, and be sensitive to very slight changes of temperature.

The inventor chose the thermal strip as the first principle of his instrument. It is well known that if a strip of brass and one of steel be riveted together, the arrangement will be very sensitive to changes of temperature. If riveted together, say, at 60 degrees, it will be straight always at that degree, but will curve in one direction at higher temperature, and in the reverse at a lower. This movement, however, of a small thermal strip is not of much power, and could not be made to directly operate the compressed-air valve, which would require considerable force. He must have power to work that valve. The conditions suggested the solution. Clearly the thermal strip could be used only as relay. Thus was born the second principle, the relay chamber.

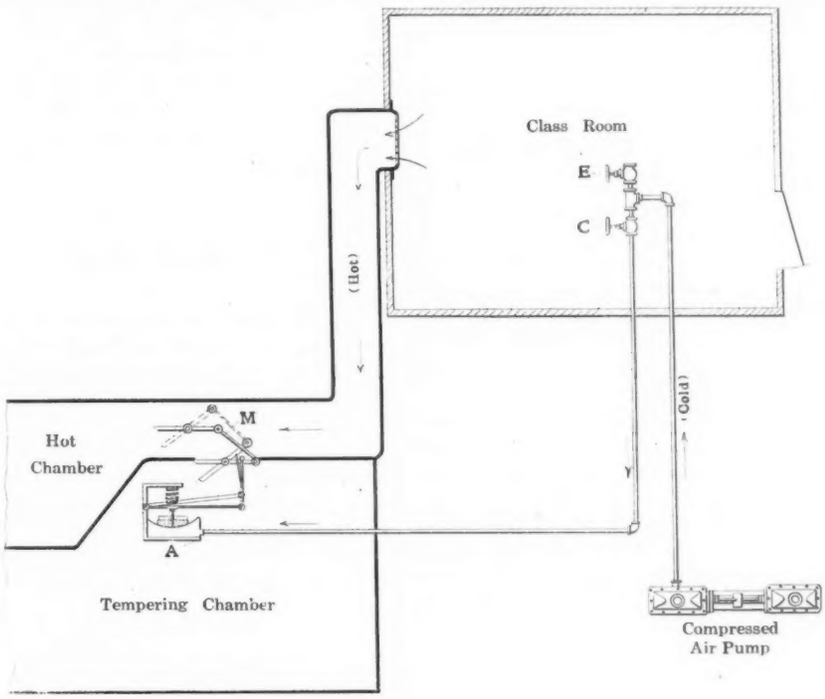


FIG. 1. THERMOSTAT CONNECTIONS

The thermal strip, he reasoned, might be made to open and close a very small aperture, say as small as a fine needle point, without materially affecting its accuracy.

So he arranged the relay chamber *R*, Fig. 2, and divided it into two portions by the flexible diaphragm *D*. Air at 15 pounds pressure is allowed to leak through the adjustable leak valve *G* into the chamber *R*, and to pass out without rise of pressure through the small opening *T* controlled by the leather-tipped thermal strip *S*. As long as the temperature remains below normal, these conditions obtain, namely, that both chambers of the instrument, *R* and *B*, as well as the large damper actuating the diaphragm connected with its outlet, are at atmospheric pressure only.

At this stage, hot air only is admitted to the room. When the temperature approaches normal the thermal strip bends toward the opening *T*, partially closing it, and the pressure in chamber *R* rises, distending the diaphragm *D* toward the open end of the hollow exhaust tube *E*, eventually closing it. The rise of pressure continuing, the exhaust tube *E* is forced backward, opening the valve *C*, which it carries, admitting air around its body to the chamber *B*, and consequently to the damper-actuating diaphragm.

It follows from this construction that the pressure in the chamber *B*, and in the actuating diaphragm, must always be closely related to that in *R*, which, in turn, depends absolutely upon the temperature surrounding the thermostatic strip *S*. The air operating the thermostat is filtered through felt and cotton to prevent clogging the small passages.

WILLIAM MCNEILL.

Chicago, Ill.

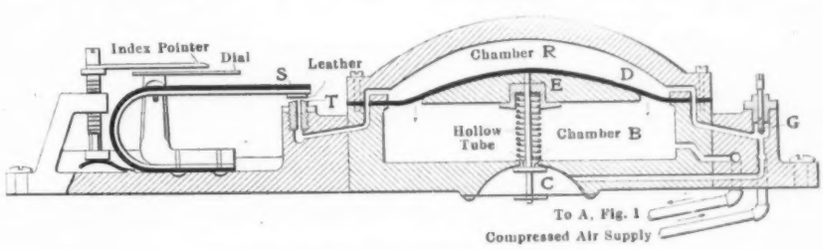


FIG. 2. THERMOSTAT CONSTRUCTION

Sawdust Burning Furnace

The sawdust-burning furnace shown by A. L. Howard, on page 21 of the July 7 number, lacks one of the essential features of a good furnace—a big combustion chamber. Take away all the earth filling and all its brickwork in the rear of the bridgewall, and give the gases from the sawdust room in which to burn.

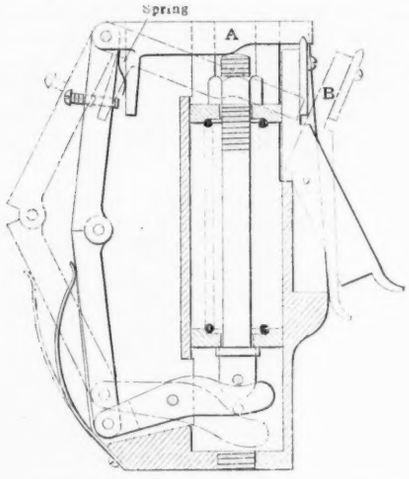
WILLIAM KENT.

Syracuse, N. Y.

A Governor Device

The reader is well aware that all Corliss engines of the present day are provided with safety devices, whereby in case of breakage of governor belt and the dropping of the governor, the steam is shut off from the cylinder.

With all of these devices it is necessary to provide means of holding up the governor at its point of maximum cut-off



GOVERNOR DEVICE FOR CORLISS ENGINES

when the engine is shut down. This is usually done by the attendant throwing a stop in position just before shutting down, while the stop automatically drops out of the way when the governor rises again.

When great overloads are met with there is a great liability of the governor dropping below the point of maximum cut-off, thereby bringing the safety device into action and shutting down the engine. It is on account of this condition that the engineer frequently fastens the stop in position while the engine is running, in spite of the possibilities of disaster to the plant in the event of the governor belt breaking. To guard against such a condition, the automatic engine stop and overload controller, shown in the illustration, was devised.

This device really combines two different functions; when the engine is at rest, it holds the governor in the position of maximum cut-off, and when the engine is running, it will not allow the governor to drop below the position of maximum cut-off until the speed of the engine is forced, by the overload, below a certain fixed limit. The device is fastened to the governor column in such a position that, with the governor at its point of maximum cut-off, the governor lever or governor crosshead will be supported on the cross-piece *A* in the sketch. This cross-piece is in turn supported by the stop *B*, which is thrown into engagement with the main casing just before the engine is shut down. When the engine is started the governor rises from the cross-piece *A*, which rises slightly, due to the action of the spring, and releases the stop *B*, which falls into the position shown in the broken lines. The cross-piece *A* is then held by the spiral spring, which, in case of accident, will collapse under any desired weight, or falling off in speed, when the levers will act and throw the toggle joint into the position shown by the broken lines, when the safety device on the valve gear is brought into play, and the engine is shut down. In short, this device serves to delay, not to prevent, the action of the governor in closing the valves, and permits the engine to run slowly under a full head of steam without, in any manner, interfering with its safety action.

It can be put in position on any governor in thirty minutes.

R. C. Holman.

Hamilton, O.

Transmitting Power of Belts

The article in the issue of April 21, on the "Transmitting Power of Belts," by N. A. Carle, is very interesting, and the charts accompanying it are very useful. It is, therefore, a pity that Mr. Carle has not taken the trouble to specify what he means by "double belts," as it would considerably change his figures.

For instance, taking his first example of a 7-inch double-leather belt on a 48-inch pulley running at 300 revolutions per minute, with an arc of contact of 150 degrees. Now, if his 7-inch double-ply leather belt is a light double belt weighing 24 ounces to the foot, the belt factor would be 416.6, and his example would be

$$\frac{4 \times 3.14 \times 300 \times 7}{416.6} =$$

63.3 *horsepower* × 87 *per cent.* = 55 *horsepower.*

If, however, his belt is a medium double belt, weighing 28 ounces, then the factor is 357, and the result is 74 horsepower × 87 per cent. = 64.4 horsepower.

In his second example, the belt is to transmit 280 horsepower, the diameter of the pulley being 10 feet and revolving at a rate of 120 revolutions per minute, the arc of contact being 180 degrees. If the belt is a standard double belt, weighing 33 ounces, then the factor would be

$$\frac{10 \times 3.14 \times 120}{303} = 124.1$$

$$\frac{280}{124.1} = 22.55 \textit{ inches wide,}$$

but, if his belt is a medium double belt, weighing 28 ounces, it is

$$\frac{10 \times 3.14 \times 120}{357} =$$

105.5 $\quad \frac{280}{105.5} = 26.5$ *inches.*

The following is a table of belt factors for leather belts:

BELT FACTORS (LEATHER BELTS).

Single	16 oz.	625
Light double	24 oz.	416.6
Medium double	28 oz.	357
Standard double	33 oz.	303
Three-ply	45 oz.	222

In the formation for determining the horsepower of belts and the belt factor, we have:

$$\frac{V \times W}{F} = H.P.$$

$$\frac{V \times W}{H.P.} = F \qquad \frac{100}{F} =$$

W in ounces or T in decimal inches.

The value in per cent. of arc of contact is as follows:

CONTACT ARC.

90°	100	110	120	130	140	150	160	170	180
50%	57	64	70	76	82	87	92	96	100

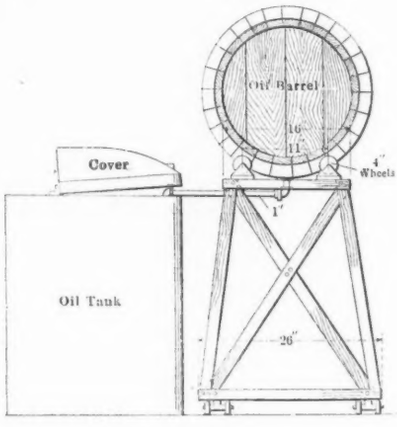
William O. Webber.

Boston, Mass.

Oil Barrel Truck

The accompanying illustration is of an oil-barrel truck which has saved me time and trouble in transferring oil from the barrel into the tank. Our engine room being in a sub-basement, I roll the truck over to the steps and transfer the barrel to the top of the truck on skids. I can then push the truck to any part of the cellar where an oil tank is located.

There are four 4-inch wheels on top of the truck, which allow of turning the bar-



OIL-BARREL TRUCK

rel in either direction without effort. After pushing the truck over to the tank a hole is bored in the top of the barrel, and a 1-inch offset pipe is inserted. The barrel is then turned over as shown in the sketch, the oil-tank cover resting on the pipe, thereby insuring against dirt or grit getting into the oil.

Henry Schultz.

Milwaukee, Wis.

A Low Voltage Electrical System for Signals, etc.

This system is well adapted for elevator signal lights, automatic engine stops, open and closed fire alarms, time clocks, tank indicators, annunciators and signals of all kinds where a steady voltage and reliable supply are required. By the use of switch *A*, set at an angle of 45 degrees, it is impossible to open-circuit the line while changing over from one battery to another. When one battery is discharged to the standard limit, the switch is thrown over, putting the fresh battery on the line and the discharged battery on the charging circuit. The battery cells contain each four negative plates and three positive plates, 7¾x7¾ inches, of the "Chloride" type. Each set comprises ten cells, eight regular and two end cells. The end-cell switches, *B* and *C*, are arranged so that they fully enter one point before they leave another. The ammeter switch *D* connects the charge and the discharge shunts *E* and *F* on the meter separately. *A* 6-volt booster *G* in series with the positive side of the line steadies the line voltage where elevator flashlights are fed from the main line. The capacity of the booster is ¼ kilowatt at 1500 revolutions per minute. The motor *H* of the booster set is series-wound, rated at ½ horsepower (4.5 amperes at 115 volts). A single-pole double-throw switch *I* closes the circuit of the booster when closed to the left and shuts it down and short-circuits the dynamo when closed in the opposite direction. The switch *J* closes and opens the shunt-field circuit of the motor. The generator *K* of the charging set is rated at 25 volts and 20 amperes, running at 1820 revolutions per minute. The field winding of the generator is excited with current at 115 volts from the same circuit which supplies the motor *L*; the switch *M* controls this supply connection. The starting box for the motor of the generator set is at *N*; *O* is the voltmeter switch with positive ground, negative ground, battery *X*, battery *Y*, line, and generator connections. Each battery can supply 15 amperes at 17 volts for sixteen hours.

M. C. SAEGER.

New York City.

Stamp Out Cribbing

The editorial on "Cribbing," which appeared in POWER AND THE ENGINEER, June 23, is a point well taken, and will undoubtedly suggest to some engineers that studying and thinking for themselves, instead of trying to get along on pretensions, is by far the better policy. On the other hand it is the writer's opinion that it is permissible to copy verbatim certain recognized engineering rules, even without using quotation marks, and do this without fear of being put down as a cribber. All of us are imitators from childhood up, and it is hard to say where originality begins, but when any party so far forgets himself as to ask the readers of a trade paper to solve his final examination questions by the wholesale, for the purpose of obtaining a diploma, such conduct is reprehensible, and the editors of POWER AND THE ENGINEER are to be commended in trying to stamp it out.

ALBERT L. ANDERSON.

Douglas, Alaska.

Knock in Valve Gear

In the June 23 number, page 994, William Ingrain asks for the cause and remedy for the knock in his Atlas engine, which appears to be in the eccentric. To make sure about the eccentric strap being too loose, I would suggest that he disconnect the eccentric rod from the strap, after which it can be turned around by hand. By this means he should be able to determine if it is necessary to remove the liners to reduce the lost motion. Care should be exercised in taking out the liners from the strap so as not to get it too tight.

Should the strap be found satisfactory, the knock may be in the links which connect the eccentric with the governor-weight arms, and as the knock does not show up until the governor is in operation it would be well to examine the links first. The construction of the link boxes will determine the remedy should the lost motion be located at that point.

There may be lost motion which needs taking up in the ball-and-socket joints where the eccentric-rod and valve-rod are connected to the horizontal rocker arm.

A. K. VRADENBURGH.

Albany, N. Y.

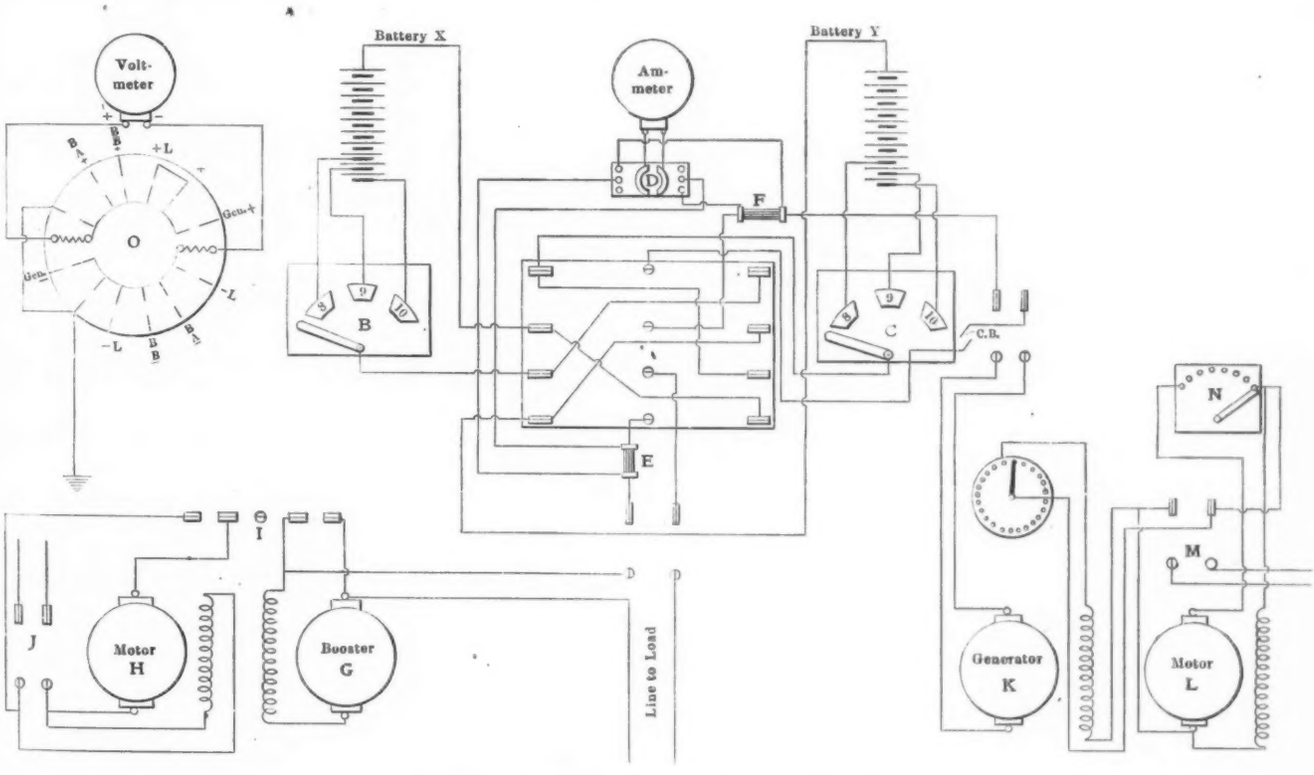


DIAGRAM OF A LOW-VOLTAGE ELECTRICAL SYSTEM

Running Engines without Cylinder Oil

In the July 14 issue of POWER AND THE ENGINEER there is a story about marine engines running without oil in the cylinder. This can be done without trouble, except the little item of coal.

I was present recently at the boring out of a steam cylinder. The motive power to drive the boring-bar was a small slide-valve engine with possibly a 3-inch cylinder. The work was started with 50 pounds of steam, but the machine man wanted 60 pounds and the little engine went off nicely with this pressure. This engine had no means for lubricating the cylinder and none was ever used, but it worked all right.

In this case the pipe for furnishing steam was taken from a pipe supplying a steam pump, connection being made by disconnecting and putting in the pipe just below the throttle-valve and lubricator.

After half a day's work the machine man had time to play with things. He therefore turned on the oil in the lubricator when no one was watching.

When the oil got in its work, the engine just shook itself free from its fastenings to the floor, and just then someone shut off steam. After that, one-quarter turn of the throttle was enough, but that engine will get no more oil, as it makes it too frisky.

Regarding the editorial on the saving of oil on railroads, it is generally known that the important railroads find it to their interest to use the oil mentioned. The same thing is done in a different way in stationary work. A good talker interests the management in saving oil; he gets permission to show what he can do and he stays in the engine room and counts the drops of oil per minute that go to the cylinders. He then puts in his oil and stays right by it for a few days until he is pretty sure of how few drops he can run with by keeping close watch. He then makes his report and the number of drops has been reduced one-half, possibly three-quarters, and a contract is made and orders given to the engineer not to exceed that amount.

The oil the engineer is ordered to use costs 65 cents, is of high viscosity and high flash test and makes some trouble in the low-pressure cylinder, because of the latter, and the viscosity is too great for the low pressure, both of which the engineer overcomes by mixing in a little engine oil.

Previous to this, the engineer had been using an oil that cost 35 cents, and the drops were less than half the size of the 65-cent oil. This is being done right along and the above story is an actual occurrence.

W. E. CRANE.

Waterbury, Conn.

Position Indicator for Valves

A position indicator for any valve can be constructed and applied to actual service without one cent of outlay. Only about five minutes is necessary to construct it. The throttle valve on the feed-pump is a very good place to attach the first one, and its actions there will lead

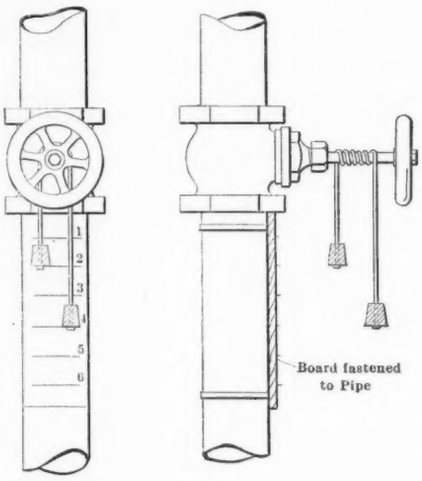


FIG. 1

to its introduction to other valves. From any distance or position about the boiler room the device shows the number of turns the valve is open. The cord is continuous, tied securely to the valve-stem, and each end is given a number of wraps about the stem. When the valve is closed the weights should hang side by side, and as the valve is opened one weight rises while the other lowers, the distance between them corresponding with the amount of opening. If the pipe

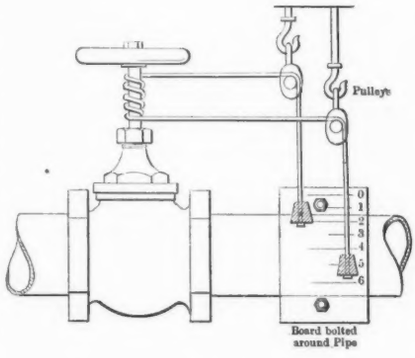


FIG. 2

is vertical, lines and figures may be placed on it (Fig. 2), or a board might be placed in position for the purpose. Should the valve-stem be in any other than a horizontal position the lines may be passed over a couple of small awning pulleys secured to the pipe by a piece of wire or clamp.

GEORGE G. MCVICKER.

North Bend, Neb.

Improving a Hotel Plant

Some years ago the writer took hold of a hotel job that had been neglected for some years, and the following recital of what was done in the way of improvements may serve to show just how bad condition a plant can get into and still give service. Before accepting the position the writer had a plain heart-to-heart talk with the proprietor and told him of some of the repairs needed, stating that if the position was accepted, it would be with the understanding that these very necessary repairs would be attended to; at the end of another year the plant would be in better condition than for several years past, but the records would also show the heaviest expense bill for any one year in the history of the plant, for instead of spreading these various items of repairs over previous years, they would be all crowded into a few months.

Of course the proprietor at first demurred, for he had had a dozen engineers in a period of about two years, and none of them had ever called his attention to the few things that the writer had mentioned.

The plant burned oil fuel, and one of the first things done was to fit up a tank gage and find out how much fuel was actually being used, also how much discrepancy there was between the amount of fuel charged on the bill and the actual amount put into the tank from the tank wagons. At the end of the first month, the boss got his first eye-opener and the fuel company its little surprise. About the first improvement was to fit up an oil pump for handling the liquid fuel from the tank to the burners. The oil pump then in service was practically worn out, and the subsequent repairs on it were about two-thirds of the cost of a new pump. Later on these pumps were installed side by side and a steam coil put in the oil tank so that the exhaust from the oil pumps warmed the oil enough to make it flow freely to the burners. The piping was so arranged that live steam could be used through this heating coil, either alone or with the exhaust from pumps, and a steam line was also connected to the oil-pipe lines, so that both suction and delivery could be thoroughly flushed and cleaned with live steam. From a casual observance, the writer supposed that the floor was made of plain natural-born dirt, but he was considerably surprised, on attempting to dig a ditch for an oil pipe, to strike a hard surface of cement about four inches under the dirt. Several loads of dirt were removed and a nice cement floor remained.

Next in the way of improvement was to take down about a wagon load of dead pipe. When anything had gone wrong

with a pipe line it looked as though a fitting had been smashed or the pipe cut off with a three-wheel cutter and a new line put in. As a result there were a large amount of dead pipe and an unusual number of unions.

No water was saved at all. There was an old tank on the roof that had been used in connection with a gravity hydraulic elevator, but had been abandoned upon the installation of an accumulator system with a tank in the basement. A sheet-iron hood was made for this old tank and the exhaust piped from the elevator pump into it, so that it served as an effective condenser. The water was piped back to a receiving tank in the engine room, utilizing for this purpose a dead line of 1-inch pipe.

An oil trap was next made out of an old kitchen tank. The exhaust steam entered the tank about 18 inches from the bottom and was carried off by a pipe from the top of the tank. The internal diameter of the drum or tank being many times that of the exhaust pipe, the velocity of the ascending steam was checked to a slow-moving fog, and on this account no grease was carried by it. It caught the oil all right, and a drip at the bottom drained it off.

The water end of the elevator pump was in bad shape, as the solid metal plungers and liners were so worn that even after the pressure was up on the accumulator, the pump would leak badly. Besides, a bolt had fallen into one of the valve chambers of the elevator and damaged the liner so that a new cup leather had to be put in every ten days or two weeks. A new liner was put in place and the main piston of the elevator had to be repacked, as it was leaking badly. Relief valves were put on the jacket kettles in the kitchen, as the cooks had a habit of turning on too much steam and bulging or blowing them up occasionally. The coils in the steam tables all had to be renewed, and their returns were piped back to the engine room into a trap discharging into the receiver. Before, the coils simply blowed outboard, and it is well known what an amount of steam can be wasted in this way. Even the float in the feed-water receiver was punctured and, of course, several leaky unions were in evidence.

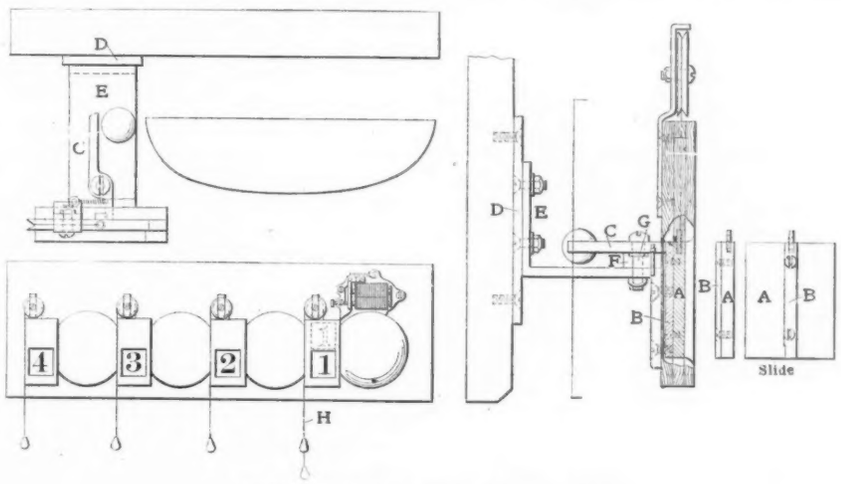
After all these improvements there was a marked decrease in the amount of fuel used, and the water meter was not worked overtime either.

J. E. BATES.

Spirit Lake, Idaho.

Annunciator for Steam Engine Bells

We have in four engine rooms three single-condensing and one compound-condensing engines, each equipped with standard engine stops and regular bells, including four in the machine shop and four in the superintendent's office. The purpose of the two groups is to tell the master mechanic and superintendent when an engine is shut down.



ANNUNCIATOR FOR STEAM-ENGINE BELLS

Formerly when a bell rang in the shop, the man nearest would look and see which one of the four had rung, if he was fortunate enough to get there before it stopped ringing, which was not always the case. This was when our fun commenced. Some would go to one engine room and some to another, each one trying to get to the trouble first.

After enduring this condition for a few months, I decided that something should be done. I looked around for a suitable annunciator to attach to our bells, but could find nothing that suited me for size, so after consulting with the superintendent, it was decided I should make one.

The sketch shows the location of the bells and annunciator, there being one for each bell. The top view shows the idea, which is the application of a simple mechanical movement. The figures are 2½ inches high and 2 inches wide and painted white on a dark-blue background, which makes them quite distinct. The piece *A* is made of cast iron to give it weight, with a steel piece *B* fastened to the back. When the figures are up out of sight the steel piece rests on the top of the lever *C*, which is held up to it by a light spring.

The piece of wrought iron *D*, which is fastened to the board, is placed as near as can be determined first, then after the bell has rung once or twice the whole may be adjusted to just the place required by means of the slotted holes in *E*. The bearing *F* for the lever *C* is counterbored to produce as little friction as possible and is held in place by the shoulder on the stud *G*, which is squared up just enough to allow an easy movement of the lever *C*. When the bell rings, the lever *C* is moved away from the steel piece *B* with the first vibration, thus allowing the cast-iron piece *A* to drop, thereby showing which engine is in trouble. Afterward the figure is pulled up out of sight by the cord *H*.

This device has been in operation about six months and has given satisfactory service.

CHARLES H. WILBUR.

Natick, R. I.

Connecting Field Magnet Coils and Reversal of Polarity

In Mr. Strother's letter on page 996 of the June 23 number it says: "If the machine is running in parallel with others, the method of correction is not so quick." etc. I think it is quicker and more simple to raise the brushes of the reversed machine and then cut in the main switch for an instant. That is, the main switch of the reversed machine should be closed with the other machines operating, just as if you were cutting-in to put on load The reversed machine should be standing idle. Pull the switch, start up the reversed machine, and its polarity will be found to be right side up.

The writer had charge of a compound-wound rotary converter a few years ago, and its polarity became reversed several times, due to lightning, bucking, etc., and as there were 10 sets of brush-holders and no provision for holding them away from the commutator, except by blocking them with wedges of sandpaper or mica placed between the brush face and the commutator, it took some time to turn the machine right side up; so I reversed the polarity as follows: I disconnected the positive main lead from the brush yoke, where it was bolted with one heavy bolt, then closed circuit-breaker, next the main switch, then tripped the circuit-breaker, opened the main switch, connected up the positive lead again, started up and cut in.

It takes less time than telling and, of course, the trolley circuit must be alive to do it.

J. E. BATES.

Spirit Lake, Idaho.

Account of a Governor Failure

Following is a description of the failure of an engine which was direct-connected to a 175-kilowatt generator and governed by a flywheel governor, which hammered badly when the engine was shutting down, or when getting up to speed, hammering worst when the engine was at about one-fourth speed. The engineer, by slowly reducing or increasing the steam supply at the throttle, could reduce this hammering to a minimum, but with the greatest care there seemed to be a certain point where the governor hammered worse than at others.

The accident occurred at the noon shut-down. As a result of the erratic habits of the governor, it was coming down to a slower speed, the engineer having turned off the steam a little at the throttle, after which he went around to the end of the engine to shut off an oil cup. The governor was hammering as usual, when without any warning, one of the heavy ends of the governor broke off, and after rolling around in the rim of the wheel for two or three revolutions, fell out and bounced from the floor to the switchboard, doing no damage.

After completely shutting off the steam and bringing the engine to a stop, it was found that no damage had been done to the engine, and as soon as another governor casting had been received from the makers, the engine was again ready for service.

The metal at the place of fracture was much reduced in cross-section by a square opening without fillets in the corners, but the fracture did not seem to show any evidence of any gradual failure. The fracture showed good, clean metal, and apparently a fresh break. The engine had only been in service a few months, and it is, of course, possible that there had been a slow seaming of the corners of the square opening which had not been open long enough to tarnish when the strength had been reduced to the point of failure.

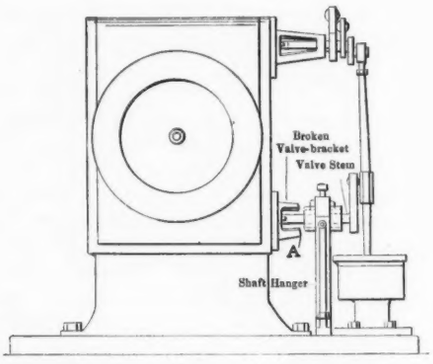
A. M. Orr.

Greenville, Penn.

Repair of a Broken Valve Stem Bracket

A friend had an accident on his engine and here is the way he made a quick repair:

He heard a thud on the high-pressure side of the engine, but as it was close to noon time, he thought he could run until shutting-down time. As he closed the throttle there was a crash and the exhaust-valve bracket broke as shown at *A*, Fig. 1. On taking off the cylinder-head, he found a follower-bolt jammed between the edge of the exhaust port and the valve, which had twisted the valve stem. He put in a new bolt, took the valve stem out and straightened it and then got a small shaft hanger and fastened it to the portion of the bed-plate supporting the dash-pot, and the bearing of the hanger was then filled with babbitt and bored out to fit the valve stem as shown in Fig. 1. Fig. 2 shows an end view of the repair job, which was made in seventy minutes.



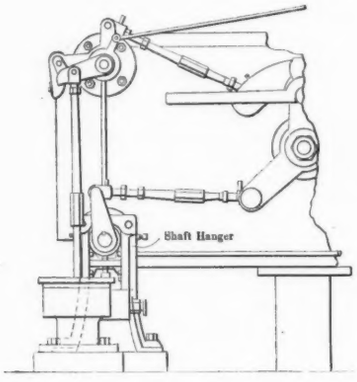


FIG. 1 REPAIR OF VALVE-STEM BRACKET FIG. 2

Thomas Sheehan.

Pittsfield, Mass.

Converting Thermometer Scales

Here is a way of converting Centigrade into Fahrenheit degrees that is quicker than that explained on page 33 of the July 7 number:

"Double, subtract one-tenth, add 32."

Example:

$100°$ C. $\times\ 2 = 200$; $-\ 20 = 180$;
$+\ 32 = 212°$ F.

$0°$ C. $\times\ 2 = 0$; $-\ 0 = 0$; $+\ 32 = 32°$ F.

$-\ 40°$ C. $\times\ 2 = -\ 80$; $-\ (-8) = -72$;
$+\ 32 = -\ 40°$ F.

The advantage of this method is not only its shortness, but the fact that the calculation can be made "in one's head," without the use of paper and pencil.

William Kent.

Syracuse, N. Y.

A Peculiar Case of Back Firing

Some time ago, in testing a vertical gas engine of new design, I experienced some trouble at first because the engine frequently back-fired, with full load as well as with no load. The mixing valve was of the design shown by Fig. 1, and had always proved to be satisfactory; therefore, bad mixture could not be the reason. As Fig. 2 clearly shows, the cylinder was seemingly free of objectionable pockets and dead corners, and the operation of the inlet and exhaust valves was perfect.

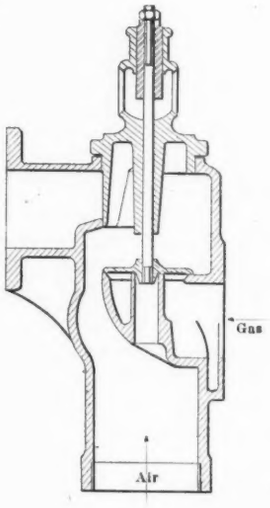


FIG. 1

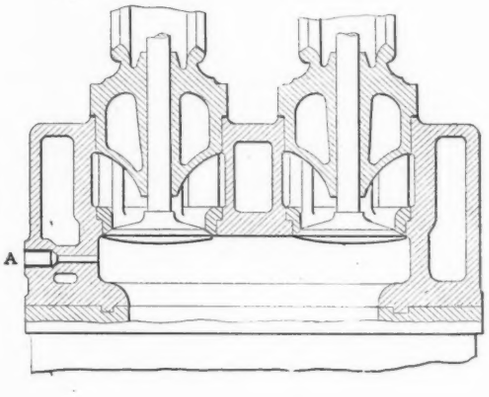


FIG. 2

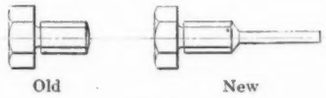


FIG. 3

Finally I found that the hole *A*, connecting the cylinder with the indicator, caused the back-firing. With the use of a new indicator stud, Fig. 3, the engine worked satisfactorily when the indicator was not used. There is no doubt that the mixture continued to burn in the indi-

cator hole during the exhaust stroke and ignited the fresh charge during the suction stroke.

Back-firing may also frequently be caused by sharp corners, which easily become heated and also tend to accumulate carbon dust, which may easily glow and ignite the charge.

H. A. MEIXNER.

Brooklyn, N. Y.

How a Shutdown was Avoided

A short time ago my duplex boiler feed-pump gave out on one side. I at once had the fireman raise the water to the third gage, knowing that I had only about 20 minutes to repair it in. I found the seat and valve screwed together, but both were out of place, the threads of the seat being rusted off smooth with the casting.

I had a short piece of wood by my bench, and cutting off a small strip, I tapered it to a wedge shape and drove it in between the seat and casting, closed up the pump and it ran for over two weeks without any trouble.

FRANK KELLOGG.

Davenport, Ia.

Utilizing a Worn Valve—An Old Gasket Cutter

The threads on the valve-stem of a globe valve used with an injector became worn and the valve was made to do service in the following manner:

The threads were filed smooth with the rest of the stem and a lever fitted to the stem as shown in Fig. 1. To operate the valve, pull the handle.

A device for removing such old gaskets as may stick to the water leg of a water-tube boiler is shown in Fig. 2. To make, take a piece of steel or an old file and shape it similar to the cutter shown. One will be surprised at the good work this device will do when used with a bit-stock.

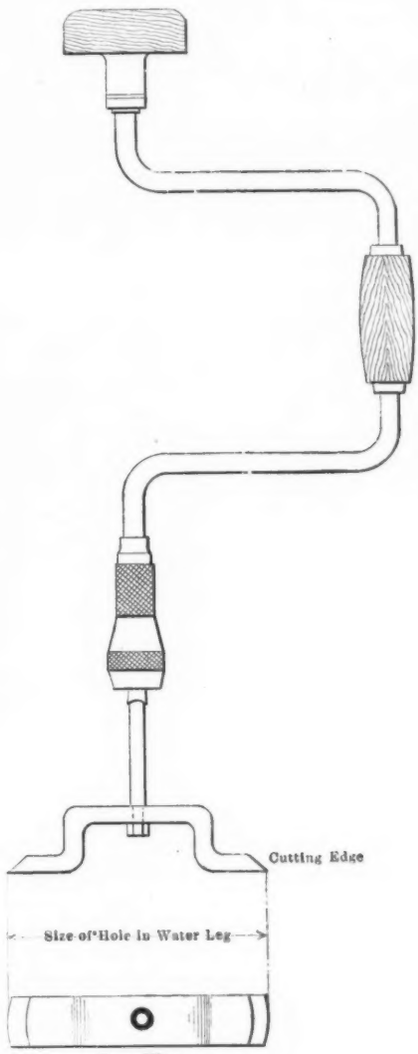


FIG. 2. GASKET SCRAPER

WALTER DAVIS.

Cape May, N. J.

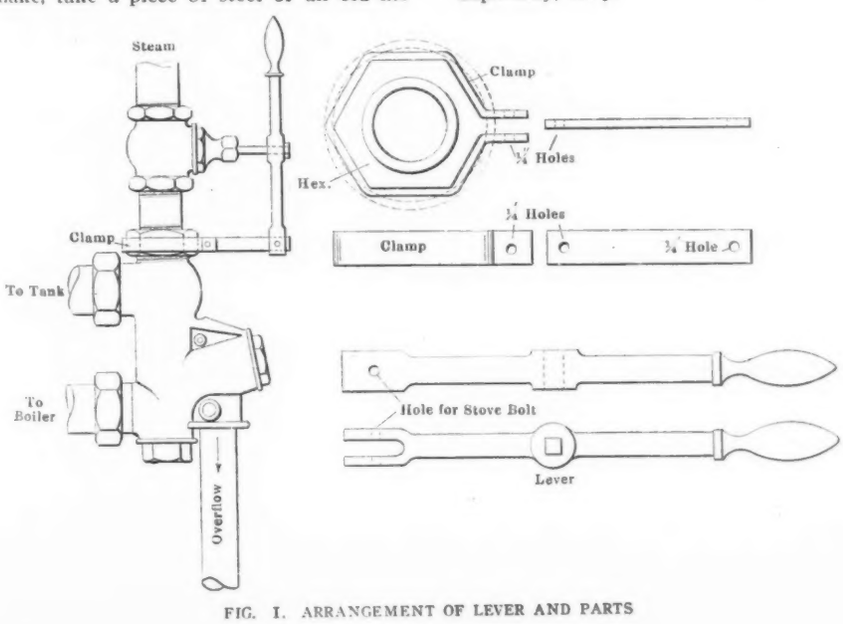


FIG. 1. ARRANGEMENT OF LEVER AND PARTS

Removing Scale from Water Tube Boilers

For getting the scale out of the tubes of a water-tube boiler, I would suggest the use of a good tube cleaner. These can be had on trial or rented from any company which handles them.

There are several compounds on the market that ought to remove the scale from the drums, or at least will soften it, so that it can be scraped off. As all feed waters are not alike, it will be necessary to have a chemical analysis made of the water to determine the kind and quantity of the preparation to use. Any reliable boiler-compound company will do this and will put it in on trial. When the boiler is once clean, with the continued use of compound, and the cleaner if necessary, there will be no more trouble with scale.

N. S. CAMPBELL.

Detroit, Mich.

No More Fly-wheel Explosions

In reading one of your recent publications, we note the not infrequent occurrence of fly-wheels bursting. An economical and effective method could be adopted whereby fly-wheels could be practically guaranteed against the danger of bursting. This would consist in taking a proportionately strong or sizable wire, fastening one end at the edge of the fly-wheel and winding it around upon the face of the fly-wheel across the entire face, and fastening the last end securely. This could be done by means of a small eye-bolt. The tensile strength of this wire, if of the right size, would absolutely control the fly-wheel, even though it should fracture.

For many years the writer has adopted the policy of surrounding emery wheels with a stationary band of wrought iron, removed a short distance from the face of the wheel. Since adopting this practice, although wheels have fractured, there has been no injury resulting. The fractured portions do not seem to have the velocity at the instant of fracture, that they have when given the impetus of the throw, and sometimes it has been remarkable how quietly the wheel will drop to the floor, and cause no disturbance whatever. The writer is confident that if all fly-wheels were equipped with the above inexpensive wire band, no wheel so equipped could cause any damage.

E. T. HARRIS.

Chicago, Ill.

The blow-off valves should be opened wide for a moment daily. This will aid in keeping boiler and blow-off pipe clean, but never open the blow-off valve or cock with a jerk, as it is liable to let go and cause a serious accident.

The High Pressure Hydraulic Elevator

Stop Valves Used with Accumulators, General Arrangement of Apparatus in High Pressure Systems; the Pumps and Their Operation

BY WILLIAM BAXTER, JR.

The Stop Valves Used with Accumulators

The automatic stop valves used with accumulators are practically the same in action as those used with the lifting cylinders, and require no special mention here. The lifting cylinder stop valves are in most cases made so that when they close the inlet, they also nearly close the outlet, this construction being used so that the elevator car may start up gradually on the return trip, and by the movement of the plunger through the first few inches of its travel the valve is opened to its full extent. The accumulator valves differ from this construction in being arranged so that when the inlet is closed, the outlet is left full open, and in like manner when the outlet is closed, the inlet is left wide open. The stops on the actuating chain of the accumulator should be set so as to close the inlet valve before the plunger rises high enough to strike the shoulder at the upper end of the cylin-

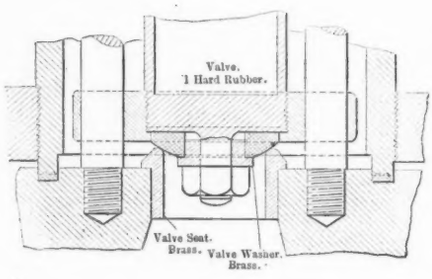


FIG. 240.

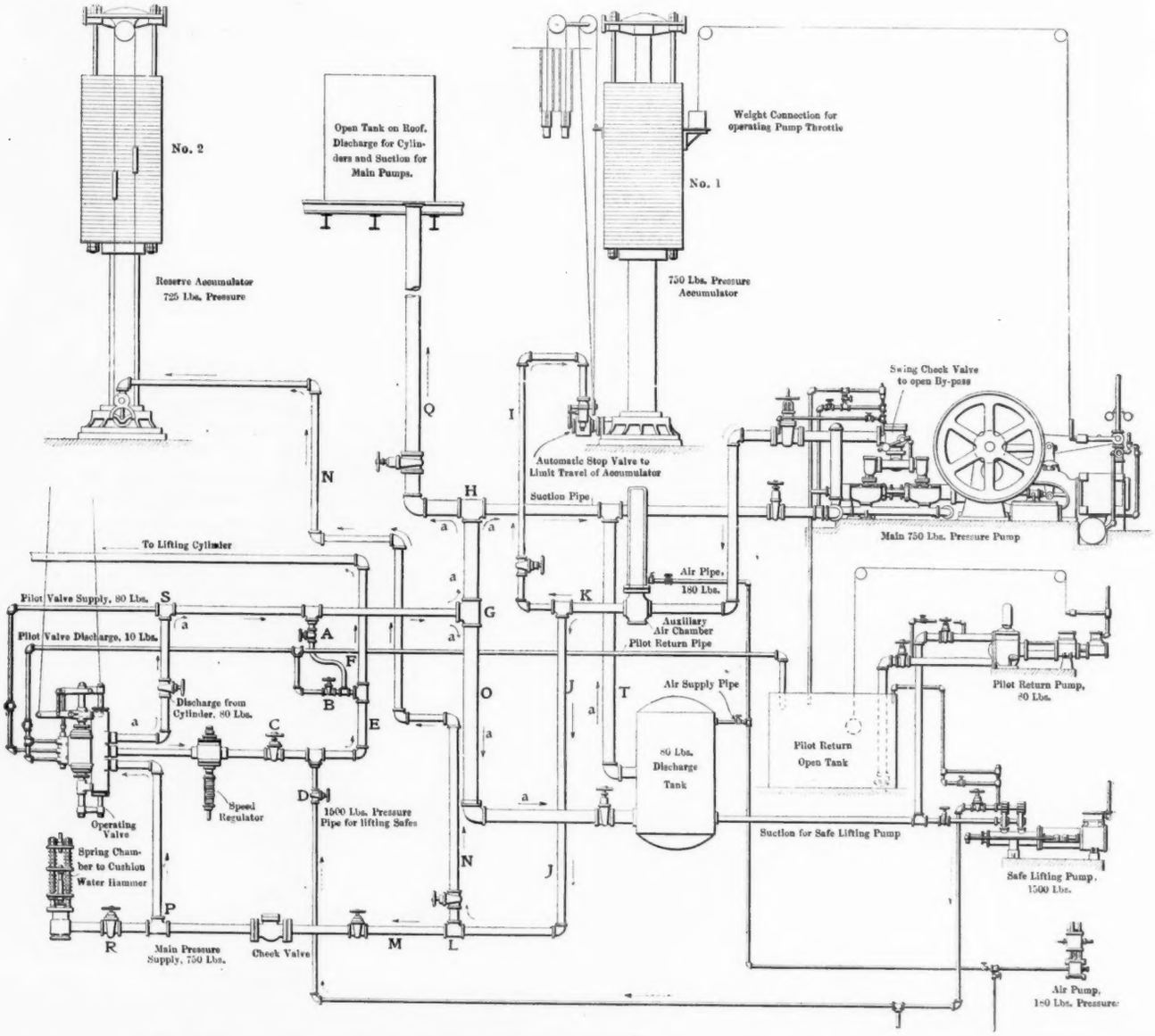


FIG. 241. GENERAL ARRANGEMENT OF MACHINERY AND PIPING FOR HIGH-PRESSURE ELEVATOR SYSTEMS

der, and the outlet valve should be closed before the weights strike the lower buffer block, but in both cases the stop should be effected as near to the mark as possible, in order to utilize as much of the accumulator capacity as practicable.

If the position of the stop balls is changed, the pump stop must also be changed; otherwise, the pump will not act in time with the stop valve. The adjustment should be so made that the pump will stop just before the upper stop closes the inlet valve, and should start up again just after the inlet valve has returned to the central position. If the pump stops after the inlet valve is closed, there will be a momentary rise in pressure in the system, and if it starts before the inlet opens there will be another momentary rise, and this should be avoided because it will cause irregularity in the motion of the elevator cars. The adjustment of the pump stop is effected by changing the length of the rope that connects the pump valve with the weight lifted by the projecting shelf on the accumulator.

The auxiliary air chamber which was shown in Fig. 228 requires additional explanation in order that the object of its peculiar construction may be clearly understood. The lower end of this air chamber is closed by a valve attached to the lower end of a copper float. The object of this valve is to prevent any of the air in the chamber from escaping into the pipe and thus finding its way into the elevator-lifting cylinders. As the water pressure is so high, the air chamber has to be charged with compressed air, the pressure of which is about one-quarter of the water pressure, so that when compressed to the latter pressure it fills about one-quarter of the upper end of the air chamber. If the chamber were filled with air at atmospheric pressure this would be compressed into a space at the upper end of the chamber so small as to have little effect as a cushion.

As the chamber is filled normally to about one-quarter of its volume with compressed air, it would be possible for some of this to escape through the lower opening if there should be a sudden and great drop of pressure in the pipes, which is possible if there is an instantaneous increase in the draft on the pipe system or a corresponding decrease in the supply. If, however, the lower end of the chamber is provided with a check-valve, the air cannot escape because the outflow of water will close the valve. It might be asked if this is the case why not use a simple check-valve and not one attached to a float? The answer is that the simple check-valve will not work. For example, suppose a simple check-valve is used to close the outlet of the air chamber; then if there should be a sudden rise in pressure in the pipes, which could occur if several elevators were stopped at the same time, this pressure would lift the check-valve and force water into the air chamber until the pressure became equal to that in the pipe, which might be, say, 800 pounds. From this time on the air chamber would be useless because the pressure in it would be greater than that in the pipe and the check-valve, therefore, would remain closed: the cushioning effect of the air would then be lost. When the valve is attached to the lower end of a float the action is very different because when the level of the water in the air chamber rises above a certain point the float lifts the valve off the seat. The level at which the water should lift the valve is that which corresponds to a pressure considerably below the normal, so that except when the pressure drops very greatly the valve is open and the water in the air chamber can pass freely into the pipe. If, however, the pressure drops low enough, the level of the water in the air chamber will drop so low that the float will not be able to hold up the valve and then it will come down on the seat and prevent any further escape of water, and consequently there is no escape of air.

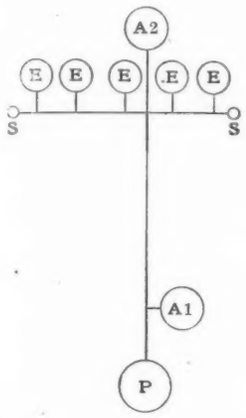


FIG. 242

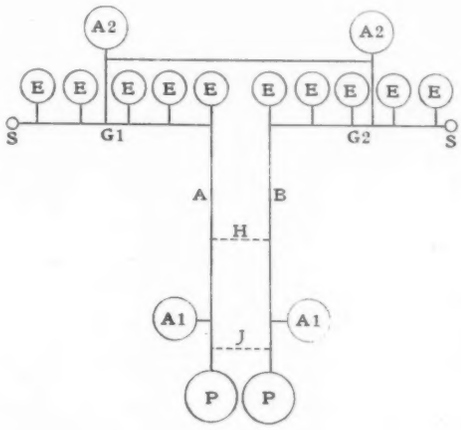


FIG. 243

The construction of the lower end of the float, the valve and the valve seat is shown in Fig. 240. The valve seat is a brass ring and the valve itself is made of hard rubber. It might be supposed that hard rubber would not stand very well in a system using such high pressure, but it does, owing to the fact that the pressure to which the valve is really subjected is simply the difference between that in the pipe and that in the air chamber, which is comparatively small. Even if the valve should wear so as not to make a perfectly tight joint it would not matter, because the water could not escape fast enough through the leak to draw air with it.

General Arrangement

The general arrangement of all the apparatus used in a first-class high-pressure elevator installation can be explained by the aid of Fig. 241 and the simplified diagrams, Figs. 242, 243 and 244. Fig. 241 shows all the apparatus used and the way in which the piping system is arranged, but is necessarily not drawn to scale, and in some cases the pipe lines are drawn in less direct paths than they would follow in actual practice, in order to avoid confusion by the frequent crossing of lines.

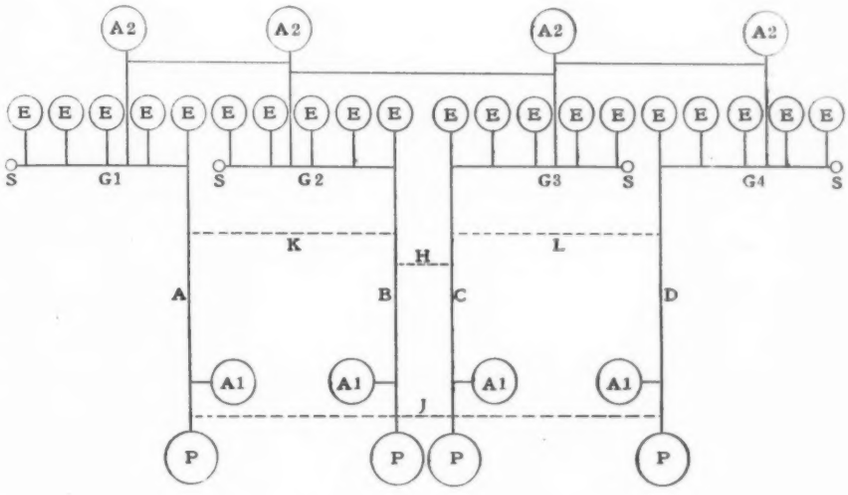


FIG. 244

Only one elevator is provided for in the pipe connections, but any number can be used up to the limit that the pump is able to supply. It will be noticed that there are two accumulators, No. 1 being arranged to stop the pump when it is full. No. 2 accumulator is provided with a stop valve only, and it is weighted so as to be lifted with a lower pressure than No. 1 in order that it may act as a reservoir. Normally, this accumulator is full of water, but if at any time the drain on the system is more than the pump can supply, it delivers its contents to the system or as much of it as may be necessary to make up the deficiency. When the demand is reduced below the capacity of the pump, accumulator No. 2 is filled again, so as to be ready to help the pump when the next heavy drain comes. This reserve accumulator is connected as near to the elevator cylinders as the construction of the building will permit, in order to reduce the loss of energy due to forcing the water through the pipes. The pipe *N*, as shown in the drawing is not very short or straight, but in practice it is made as short and straight as practicable.

The Pumps

The pumps are generally made so that when they stop pumping to the system they do not actually stop moving; they continue to run, but the water circulates through a by-pass and the steam valve is opened just enough to keep the piston moving very slowly. This arrangement is used in order that when the pump is called upon it may get under full headway quickly and thereby avoid the possibility of a drop in pressure.

The course of the water from the pump is indicated by arrows drawn in full lines; it passes first through the auxiliary air chamber (the one with the float-supported valve) and on reaching the junction *K* can run up the pipe *I* to the accumulator, or down the pipe *J* to the junction *L* whence it can flow either through *N* to the No. 2 accumulator or through *M* to the main valve of the lifting cylinder. If there are several elevator cylinders they can be connected with the supply pipe *J*. Examination of this piping will show that if accumulator No. 1 is not full, water may pass into it and also flow on through the pipe *J* to the pipes *N* and *M*; through the first of these it flows to accumulator No. 2 and through the other to the operating valve of the power cylinder. If the demand is greater than the pump can supply, water will flow out of accumulator No. 1 to make up the deficiency, but water will not flow out of accumulator No. 2 unless the drain is so great that accumulator No. 1, together with the pump, cannot keep the pressure up above that for which No. 2 is adjusted; in this case the latter accumulator will also discharge into the system. After the water passes through the operating valve it flows through the speed regulator and thence into the pipe *E* and to the lifting cylinder (not shown). Returning from the lifting cylinder it comes through the same pipe *E* and the speed governor to the operating valve, and through the latter to the discharge pipe, following the path of arrows *a*. At *G* it can flow up into the open tank on the roof through pipe *Q*, or into the pump-suction pipe, or it can flow down through the pipe *O* into the discharge pressure tank, and thence through the pipe *T* to the pump suction.

The object of providing the discharge pressure tank is to cause the discharge to flow out so freely as not to give the car a jerky motion. If this tank were not provided the discharge would have to pass to the junction *H* and then divide between the pump suction and the roof tank, going to the latter through the pipe *Q*. The latter path would offer considerable resistance, as the tank would be about 175 feet high, and a column of water of this hight cannot be forced upward suddenly. The discharge pressure tank is located in the basement, on the same level as the discharge pipe or possibly lower, and not far from the elevator cylinders; consequently, the water can flow into it with comparatively little resistance. The actual result of this arrangement is that the pressure discharge tank receives nearly all the water and the roof tank serves simply to keep the pressure constant. The pipe *T* is shown as tapping the tank rather high up in the side, but in practice it enters near the bottom so as not to draw air into the pumps.

From the tee *S* in the discharge pipe a connection runs to the pilot valve to actuate the motor piston that moves the main valve. The discharge from the pilot valve runs to the open tank shown to the left of the pressure tank, and from this tank it is pumped by the small pilot-return pump into the suction of a small extra-high-pressure pump that is used to lift safes and other heavy weights.

At the end of pipe *M* is placed a spring-cushion chamber to receive and subdue the impact of the stream of water when the operating valve is closed. This spring-cushioning device was described in connection with Fig. 231, April 28, and in the present diagram the way in which it acts is very clearly shown. When the flow of water through the operating valve is stopped, the current in the pipe *M* will send the water forward into the cushioning chamber, where its momentum will be absorbed in pushing the plunger out and compressing the springs. When the water comes to a state of rest, the springs force the plunger back into the cylinder, ready for the next blow.

The air pump shown is not kept in operation all the time; it is used only when it is necessary to replenish air in the pressure tank, or in the air chambers. When the air in the tank is not sufficient the pump is set in motion and then the valve in the air pipe is opened and air is allowed to flow into the tank until the water gage shows the level to be at the proper point.

Elevators for Heavy Service

In all large buildings, where there are several elevators, one of them is arranged so as to lift heavy weights, such as safes or large machines. This elevator is generally capable of lifting about three times the load of any of the other elevators, and as it is only required to do this work occasionally, simple means are provided to accomplish the result. The means consist in providing a small pump that can develop a pressure sufficient to lift the required load and this is connected with the piping of the elevator in such a way that by manipulating hand valves the car may be caused to run either up or down. The arrangement shown in Fig. 241 is actuated as follows: If it is desired to lift the load, the valves *A*, *B* and *C* are closed and the valve *D* is opened, then the safe-lifting pump is started and the water follows the path of the dotted arrows to the lifting-cylinder pipe and to the cylinder, and the car moves upward. The velocity of the car will be very slow. If it is desired to run the car down, the valve *D* is closed and the valve *A* is opened; then the water from the lifting-cylinder pipe will escape into the discharge pipe and through it to the pressure tank. The car can also be run down by opening the valve *B* with *A* either open or closed; the speed will be greater if *B* is opened. It is not actually necessary to close the valve *D* in coming down. From the foregoing it will be noticed that when the safe pump is used to lift an extra heavy load, the main operating valve is not used; in fact it is cut out of service by the closing of the valve *C*, and the movement of the car is controlled entirely by the hand valves *A*, *B* and *D*.

While the diagram, Fig. 241, shows very well the general arrangement of the high-pressure system with only one elevator, it leaves considerable to the imagination when one considers an extensive plant containing a large number of elevators and a corresponding number of pumps and accumulators. To make the arrangement of such an installation clear, Figs. 242, 243 and 244 are given. Suppose that a building is equipped with twenty elevators, and assume that there are four main pumps and eight accumulators. Such a system can be arranged in many different ways; it can be connected all in one general piping system, or it may be divided into two, four or even more separate systems. Suppose it is divided into four separate systems, then each one would consist of five elevators, two accumulators and one pump, and these could be connected in the manner shown in Fig. 242, in which the circles *E* represent the elevator cylinders, *P* the pump, *A1* the accumulator that stops and starts the pump, and *A2* the reserve accumulator shown

in Fig. 241. At each end of the pipe line that connects the elevator cylinders is shown a spring cushion *S* to subdue the water-hammer effects. Four independent systems like this could also be made so as to be connected with each other or disconnected at will. In Fig. 243 is shown an arrangement by means of which two of these units could be connected into one, by simply providing the pipe connections *H* and *J*. With the first pipe connection either one of the pumps and its accumulator *A1* could be used to supply the entire ten elevators on an emergency, and by making the connection *J*. Both the *A1* accumulators could be put in service, which would be the best arrangement, as when the pump capacity is small the accumulator capacity should be large.

Fig. 244 shows how the four units can be arranged to be independent if desired, or to be connected two and two, or three in one system and one independent, or all four in one system. The pipe connection *H* will join the two center sections, and *K* and *L* will connect the side sections independent of each other if *H* is disconnected. Many combinations can be made by means of proper connections between the pipe lines *A, B, C* and *D*. This is also true of the connections between the *A2* accumulators. This way of arranging the piping is advantageous not because any economy can be gained by cutting up the plant into several sections (in fact this is not advisable as a rule), but because if there should be a breakdown in any part, the other parts can be made to take its place while repairs are being made. For example, if one of the pumps gives out, the pipes leading to it can be closed, and the elevators it supplies directly can be connected with the remaining pumps.

There are probably no two elevator installations of large size that are arranged exactly alike, and although the differences between them are due to a considerable extent to the notions of the architects of the building, the owners, the engineers and others interested, not a small portion of it is due to the difference in the conditions controlling the case, hence, an arrangement of an installation precisely as shown in Fig. 244 might be hard to find. In these last three diagrams only the supply pipes have been shown, in order to avoid confusion and to present clearly the way in which the pumps, the elevator cylinders and the accumulators are connected with each other to obtain the best results.

A Brake on the Flywheel

By Gerald E. Flanagan

A device designed to aid in preventing an engine from racing is indicated in Fig. 1, which is a diagrammatic sketch illustrating the principle of the brake. Such an emergency device might be made supplementary to any apparatus for controlling the engine by shutting off the steam. It consists of a brake block arranged to be applied to the rim of the fly-wheel with such force that the friction will absorb the entire power of the engine, and in doing so hold the speed down to, or even below, normal, and thus afford time for shutting off the steam by means of the customary hand-operated valve. The force by which the brake is applied to the wheel is rendered active by a governor, which, in turn, is influenced by the acceleration of the wheel itself, or the shaft to which it is rigidly attached. Thus the brake does not become operative until the speed limit is exceeded.

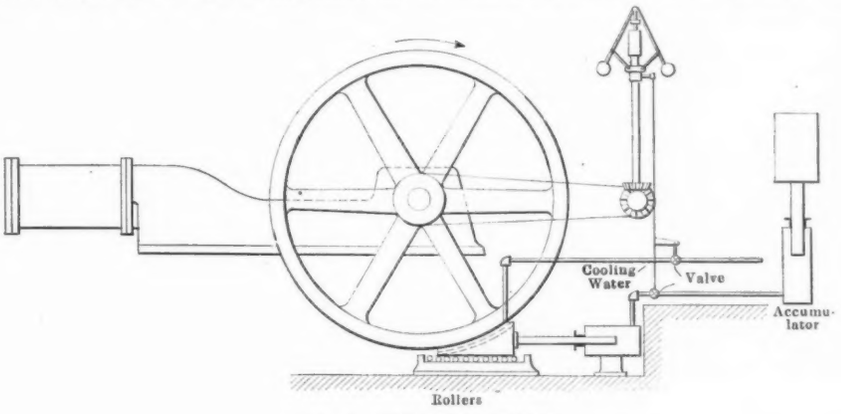


FIG. 1. HYDRAULIC BRAKE

Such a device should not be powerful enough to stop the engine suddenly, or it might cause the wreck which it is intended to avoid. With friction rollers beneath the brake block and the engine running over, the pressure of the block would be increased by the action of the wheel itself from the moment contact was made with its rim, and might continue to increase so as to draw the block in too far, lift the wheel and throw the shaft from its bearings. This might be prevented by limiting the travel of the block by mechanical means, or by making it of such a form that this tendency would be overcome. Placing the block higher up on the wheel rim in place of immediately beneath it, is one method that would be effective. A better device than the one shown would be a brake arranged to grip the wheel on each side in place of upon the edge, the forces applied balancing each other.

The absorption of the full power of an engine in this manner means the transfer of considerable energy in the form of heat; the block would grow very warm, and probably require to be water-cooled, the same movement of the governor which brings pressure to bear upon the brake being utilized to turn on the circulating water.

A few figures are given showing the heating effect of absorbing 2000 horse-power. The number of heat units per minute in 2000 horse-power equals

$$\frac{2000 \times 33{,}000}{778} = 84{,}800,$$

which is sufficient to raise the tempera-

$$\frac{84{,}800}{62} \begin{cases} = 1368 \text{ cu. ft. of water raised } 1^\circ \\ = 22.8 \text{ cu. ft. of water raised } 60^\circ \\ = 168 \text{ gal. of water raised } 60^\circ \end{cases}$$

The possible rise in temperature of the wheel itself should be noted, but it does not appear to be serious, as only a small portion of the heat generated could be retained by it.

The rise in temperature of a 100,000-pound cast-iron wheel absorbing 2000 horse-power for five minutes equals

$$\frac{84{,}800 \times 5}{100{,}000 \times 0.1298} = 32.5$$

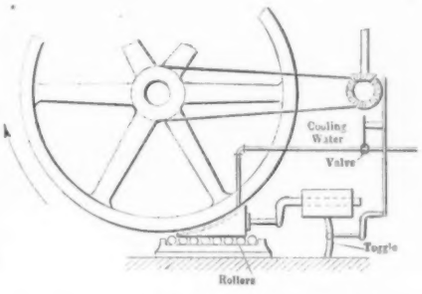


FIG. 2. BRAKE SET BY WEIGHT

degrees, 0.1298 being the specific heat of cast iron.

Fig. 2 shows the pressure applied to the brake by means of a weight in place of a hydraulic cylinder. Such a method of protecting a fly-wheel as the previous illustration is doubtless open to criticism of an unfavorable kind, but discussion of the question from various points of view is one of the things that is needful, and the subject should not be permitted to rest until means have been found to prevent a large percentage of the fly-wheel accidents that are of such frequent occurrence.

Boiler Explosion at York, Penn., Kills Ten Men

It Was an Old Boiler, Badly Worn, Had no Steam Gage and the Safety Valve Had Blown but Once in Eighteen Years

BY WARREN O. ROGERS

By the explosion of a 60-inch return-tubular boiler at the York plant of the Susquehanna Iron and Steel Company, York, Penn., shortly before 3 o'clock Monday, August 10, nine men were instantly killed and 20 injured, one of whom died the next day. That more fatalities are not recorded is because the plant was shut down at the time of the accident, the victims being engaged in repair work. Figs. 1 and 2 show the demolished condition of the plant and also suggest that the escape of many of the injured was miraculous. The property loss will amount to from $10,000 to $15,000.

FIG. 1. SHOWING HAVOC WROUGHT TO MILL BY BOILER EXPLOSION AT YORK, PENN.

The conditions governing rolling-mill boiler practice differ from those found in any other phase of steam engineering. The heat from the fire used in making a heat of metal after doing its work in the furnace is passed through a brick flue to an ordinary cylinder boiler set in brickwork above the heating surface, as shown in Fig. 2 at the left of the wreckage. Many of these boilers have no tubes, and the heat after passing along the bottom of the shell escapes to the short stack shown. The number of boilers will depend upon the number of heating furnaces, each furnace in this instance having one boiler placed in such position or place as convenience dictated. No steam gages were used on any of these boilers, dependence being placed entirely on the safety valves, which seldom, if ever, blew off, as all the steam was used as fast as generated.

The boiler which exploded was of the ordinary return-tubular type, with the usual brick setting, and was fired with coal, as in ordinary practice. This boiler was connected to the 6-inch pipes running from the shell boiler to different engines and pumps throughout the plant, and was used as an auxiliary to help out the others when they were unable to produce sufficient steam. The boiler was installed about 18 years ago, and it is stated that it was a second-hand boiler at that time; therefore its age is not known. It was not equipped with a steam gage, had no water glass, and the safety glass had been known to blow but once in 18 years, and then it was found that the stop valve between the boiler and the steam main had not been opened. What pressure was reached before the valve blew was never known.

The original arrangement of steam piping remained intact until Sunday, August 9, the day before the explosion, when the tubular boiler was disconnected from the main steam line and connected by a 2-inch pipe to a small engine used for driving lathes for repair and machine work. This was done because a new and large boiler had been installed to work in conjunction with a new heating furnace. The boiler was fired up Monday morning for the purpose of running the lathe engine, and matters moved smoothly until 9 a.m., when the injector failed to operate. A pump was then used to supply water up to the time of the explosion. The low-water theory was seized upon as the cause of the explosion, as usual, but the fireman is said to have stated that three gages of water was being carried, that he had stopped the feed pump for that reason, and was on his way for a drink of water when the explosion occurred. In so far as his movements are concerned, they seem to be borne out by the fact that he was found where he would have been had he been carrying out such intention.

That the explosion was terrific is evident from the wreck of the plant and the complete destruction of the boiler. The force of the explosion expended itself in a direction at right angles to the longitudinal position of the boiler, thus showing that the shell gave way from end to end; the heads were blown in opposite directions. Such portions of the shell as have been found were straightened out into practically flat sheets, the tubes bent and twisted and the rear head blown into several pieces. The debris was scattered over an area of several blocks, and one large section of the boiler sheet containing the steam dome was blown through the air for a block and a half, lodging on

FIG. 2. A CLOSE VIEW OF THE WRECKED PORTION OF THE PLANT

the rear of a dwelling house and then, careening sidewise, tearing the first and second stories of the house. This is shown in Fig. 3.

The boiler originally stood at the point designated by the cross in Fig. 2, parallel with the engine, the flywheel of which is shown. It was here that the ten men employed in boring out the valve chambers and overhauling the Corliss engine met their death. The engine bed was broken off close to the main pillow block, but was pulled around somewhat during the work of removing the bodies of the dead and left as shown in Fig. 2.

The officials of the company deny that the boiler was in an unsafe condition, and that the talk of the boiler having been condemned is all nonsense. They state that it had been inspected and given a thorough overhauling about a month ago, and that the boilers in the plant were washed out and inspected on an average of once or twice a month. They also state that the real cause of the explosion is

FIG. 3. DAMAGE DONE TO DWELLING

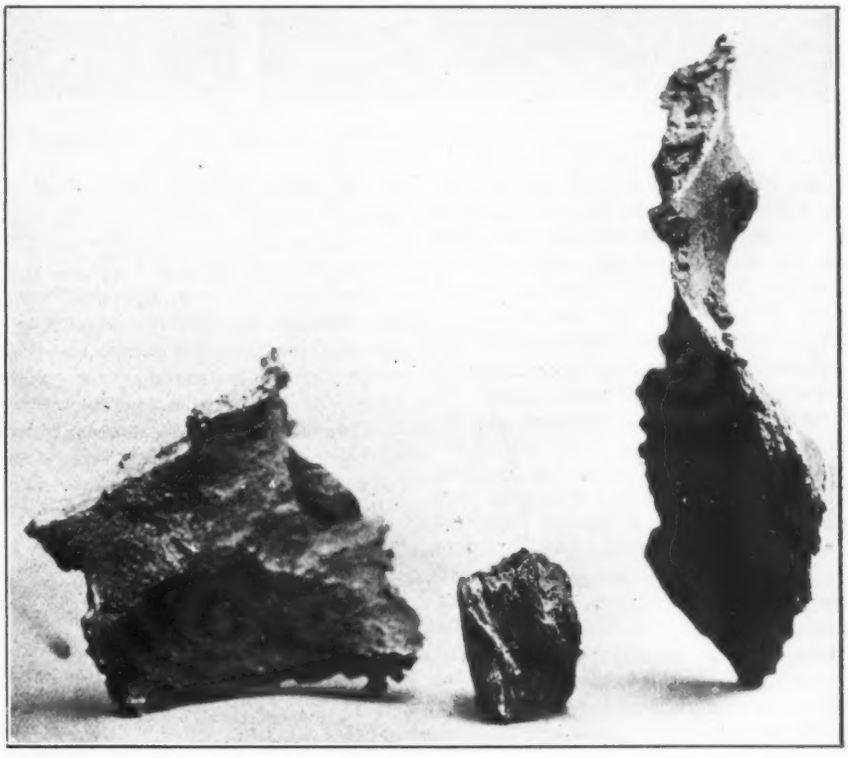


FIG. 4. PIECES OF THE BOILER SHELL (ENLARGED)

not known, and declare that there was no local weakness in the boiler, as shown by the fact that the heads went in opposite directions, while had there been a weak spot the natural inference would be that this would have given way first. The officials also deny that the boiler plates were thin, pitted, burned or cracked, as stated by those who have examined the torn pieces, or that the tubes were thin.

Putting aside the statements of those connected with the plant and those who examined the wrecked boiler out of curiosity, the following facts are authentic:

The boiler was not in a safe condition to operate because it was not fitted with a steam gage; there was no knowledge at what pressure the safety valve blew off, or if it would blow off at all; the boiler shell directly over the fire was badly pitted, the plates in places not exceeding 1/16 inch in thickness. This is shown in Fig. 4, where three pieces of the boiler shell are shown somewhat enlarged, one showing the pitting, one the thinness to which the plate had wasted, and the center piece showing the original thickness of the plate. These samples were from the sheets of the boiler after the explosion. The original thickness of the plate was 3/16 inch. The plate also shows unmistakable signs of burns, while the numerous cracks which were disclosed by the explosion show without a shadow of a doubt that they were not new. An examination of the front head showed not only a large blister, but also that the plate, where riveted to the head, had been cracked through from rivet to rivet, and that the corroded condition of the edge of the plate is the mute but convincing evidence that the crack, over 18 inches long, was an old one; see Fig. 5, which also shows a section of the shell. Every part of the boiler examined shows that prior to the explosion it was in a most deplorable condition.

That there may have been a slight warning of their impending doom is suggested in the fact that of the ten victims all but one were mutilated in the face and front part of the body. Many faces and heads were merely staring cavities, lacking any features. One man was recognized by a tag, another by a pass-book, one by a fragment of closely cropped hair, and another man was found headless. There were many narrow escapes by those employed in the vicinity, and it is extremely fortunate that many more were not added to the large number of killed and wounded.

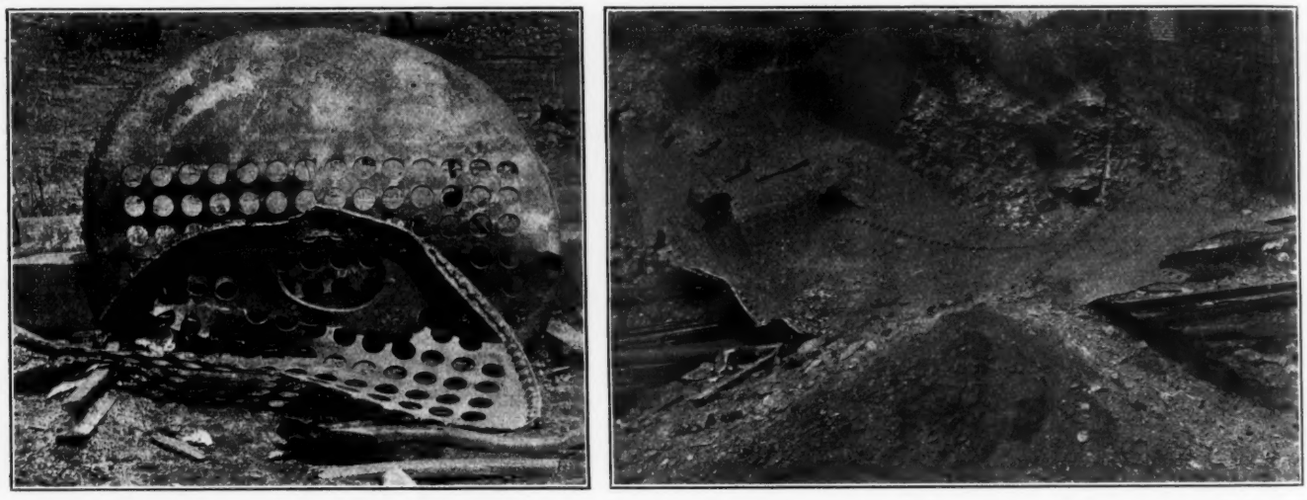


FIG. 5. SHOWING OLD CRACK, AND A SECTION OF THE SHELL

For and Against the Steel Stack

By H. A. Cozzens, Jr.

There have been numerous articles on the "Steel Stack," but the majority deal with the construction and design rather than the relative advantages of the steel stack, as compared to those of the other types of stack, and so I take the liberty of expressing my views as to "For and Against the Steel Stack."

Advantages

Where the soil is of low weight-bearing character the steel chimney offers an advantage, as in such territory the soil is often unable to bear the weight placed upon it by the erection of a masonry stack, and either another means of obtaining draft or a lighter chimney must be installed. The steel stack is practically lighter in weight than any other chimney of the same flue diameter and for this reason the steel stack is used in such cases. Thus the same amount of draft may be obtained as with a masonry stack, but without the liability of the stack tottering owing to the nature of the soil.

Stacks of brick are made up of thousands of brick held together by mortar, which being a different material from brick, makes the stack liable to many small cracks due to the action of the weather. Thus no matter how well a masonry stack is constructed, it is in most cases susceptible to leaks, and this is one decided disadvantage of the brick stack. Through these leaks the air is drawn in from the outside and this cool air at once counteracts the influence of the heated gases, and in this manner the draft is impaired. But in the case of the steel stack, if it is well constructed, so that the joints are rust-proof and calked, and the proper care is given, the leaks may be reduced to a much smaller number than those which occur in brick stacks. A greater and more perfect draft is thus insured by the use of the steel stack.

In most cases the appearance of an appliance does not always decide its usefulness or efficiency, but it may be mentioned in passing that the steel stack gives the impression of being the most business-like of all chimneys Perhaps this is the result of the recent move toward the decoration of the masonry chimney, as in many cases the chimney attracts attention more as an advertising medium and ornament than as an essential part of the plant.

In power-plant work the steel stack may be erected so as to occupy less space than any other type of stack; that is, excluding the space needed for the supporting guy ropes. These ropes may be arranged so as not to conflict with the buildings or passageways about the plant. Steel stacks do not offer as great a resistance to the wind as do stacks of masonry or other materials. The reason for this is that the steel stack has a much smaller diameter than the other types having the same flue diameter and thus there is much less surface presented to the wind pressure.

The steel stack presents many advantages for use in temporary installations; that is, as in public work where equip-

ment is needed in one place but for a short period, and then the installation must be moved elsewhere. Steel stacks being much lighter than stacks of other materials, are much more easily erected than those of other types. Then the simplicity of construction of the steel stack enables it to be more quickly assembled than in the instance of the masonry stack. Another advantage in this line of work is encountered when the stacks are transported. It would be an utter absurdity to attempt to transport a masonry chimney without practically demolishing it, while the steel stack may be transported after being taken down in sections of suitable length.

Considering the initial cost of steel stacks, they are in most cases found to be cheaper than those of other materials, although in some cases the cost of a well constructed steel stack exceeds that of a masonry stack. The difference in weight between steel and other stacks enables a smaller foundation to be used with the former type, thus reducing the cost of erecting the foundation. The relative costs of the materials used in the two types will show favorably for the steel stack and the time needed for erection and the cost of labor will be found to be less than the respective costs of the other types of stack.

Disadvantages

One of the disadvantages of steel stacks, and one of the greatest drawbacks to their use, is the susceptibility of the stack to rust. Unless the stack is kept painted with the best of rust-proof paints it will in a short time deteriorate in both value and efficiency. Keeping the stack well painted entails an expense which in time represents no small item, and thus the economy in the use of steel stacks tends to be reduced to a point far below that reached by the use of a masonry stack. Rusting of steel stacks has been greatly reduced by the application of new methods of draining during the last decade.

Another disadvantage in the use of steel stacks occurs in most cases where the stack is cheaply constructed and is not lined. This disadvantage is that when using steel stacks the acid-forming gases attack the interior of the stack, causing it to rust and waste away. This disadvantage may be overcome by lining the stack; but the cost of this often amounts to that of a well constructed chimney. From the preceding it may be gathered that the life of the ordinary steel stack is not as long as that of a masonry stack and in many cases the life of a well constructed self-supporting stack has been known to be less. Of course, the life of a stack is proportional to the amount of care given it; that is, if kept well painted and calked it lasts much longer and is more efficient.

The unlined steel stack is subjected to a loss due to radiation, which comes high and reduces the draft, as the latter is dependent on the relative temperatures of the flue gases and those of the surrounding atmosphere. The only remedy for the reduction of the draft loss is in the lining of the stack part way or throughout. Unless a stack is self-supporting, a disadvantage is encountered in that the guy wires used to support the stack often conflict with the other apparatus so as to inconvenience travel and operation.

The Most Frequent Cause of Boiler Explosions

By William H. Boehm

If I were asked to state the most frequent cause of steam-boiler explosions, meaning the tearing asunder of any part of a boiler by force of steam pressure, I would unhesitatingly say, *scale*.

That this is not generally known to boiler owners is a reasonable assumption, else inspectors would find scale in fewer boilers and boiler owners would exhibit greater interest when scale is found and reported to them. Many boiler owners, it is true, have learned that boiler waters usually contain more or less scale-forming matter. Some have learned that an accumulation of scale impairs the efficiency and increases the fuel consumption of a boiler. Some have learned even that an accumulation of scale allows an overheating of the boiler plates. But it usually takes an expensive object lesson in the way of a bag, or rupture, or explosion to make any deep impression as to the real danger of scale formation.

No boiler owner wants an object lesson of this sort. No boiler owner wants to jeopardize his own life and property and the life and property of others by fostering any condition that is dangerous. But just as certainly as scale is allowed to accumulate to any considerable thickness in a boiler, just so certainly is a bag or rupture of the boiler inevitable, unless perchance the scale happens to be of a spongy formation, which is not often the case. Just why this is so is shown by the following simple experiments:

How to Prove it

Take a piece of common writing paper and form out of it a pan or box by folding up the edges and fastening them at the corners with pins. Pour water into the paper pan thus formed, place it on a gas stove and turn the flame on full. If the pan is watched closely it will be found that as long as any water remains in it the paper will not burn; will not even char.

Take an ordinary granite-iron or tinned-iron stew pan and firmly glue to its under side a *postage stamp*. Pour water into the pan and place it on a gas stove so that the postage stamp will be in direct contact with the flame. Leave the pan on the stove until the water has boiled violently and then examine the stamp. The stamp will not even be charred, much less burned. In fact, it may be removed from the bottom of the pan and used to post a letter in the usual way.

Now, put into the pan a mixture of water and portland cement half an inch thick. This when set will be the equivalent of half an inch of scale. Repeat the experiment made before and it will be found that the stamp will burn up very quickly.

It is the Same with Steam Boilers

If the water comes in direct contact with the thin plates, the heat is absorbed, the temperature of the plates remains practically the same as the water, and no harm is done. If there is a considerable thickness of impervious scale in the boiler, the water cannot absorb the heat as fast as it is put into the plates by the furnace; as a result, the plates become overheated, get red, become plastic and finally give way to the force of steam pressure, causing a bag, or a rupture, or a violent explosion of the boiler.

Other Dangers from Scale

Scale endangers the safety of boilers in other ways. It clogs the feed pipes, preventing the feed water from entering the boiler freely. It clogs the connections to the steam gage, causing it to read incorrectly. It clogs the connection to the water gage, causing it to indicate ample water when none at all is in the boiler. Pieces of it get under valves and prevent their closure. A blow-off valve, for instance, screwed down hard and thought to be shut, recently allowed all the water to leak out of a boiler and caused its burning into a mass of warped plates and bent tubes fit only for junk.

Scale in boilers, therefore, is a serious matter.

To Prevent Scale Accumulation

In order to prevent its accumulation it is good practice to eliminate the scale-forming matter from the feed water before allowing it to enter the boiler. This can be accomplished either mechanically by means of separators or chemically by treating the water in vats especially arranged for the purpose. If preferred, compound may be fed with the water into the boiler, but in such case the water should be analyzed and the proper compound prescribed by a chemist making a specialty of such matters. Kerosene oil fed into the boiler has proved beneficial in many instances. Zinc plates attached to the boiler so as to make intimate electrical contact have been used, also, with varying degrees of success.

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

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Compressor Explosions

On page 297 is recounted another instance of disastrous explosion of the contents of a compressed-air system. While such an occurrence is the natural and inevitable result of the conditions established, this class of "accident" has not become so common, or has not been given the amount of publicity necessary, as to put erecting and operating engineers upon their guard. In an oil engine air is forced through or over oil in the carbureter, and, taking up a sufficient amount of the volatile fluid to make an explosive mixture, is exploded in the cylinder. In some forms of engine a charge of air is compressed until its temperature is above the ignition point of the oil, and as the engine passes the center the oil is injected and burns explosively in the cylinder.

In the arrangement described by Mr. Newton all the elements for this action are present, ample opportunities for the oil to collect and to present broad evaporative surfaces to the heated air passing over and perhaps through it; a light engine oil with a comparatively low ignition point at atmospheric pressure, which becomes much lower as the pressure is increased, and finally a hot day with a high initial temperature carries the final temperature above the point of ignition of the rich explosive mixture in the pipe, and the explosion occurs.

This is the only instance which we recall of such an accident with a compound compressor. The cooling of the air between the two stages necessary to realize the advantage of compounding is usually sufficient to keep the final temperature within the limit of safety. Many of the earlier intercoolers were sadly inadequate, however, and the article is silent regarding them.

The Fool's Paradise of the New York School Board

In a preliminary report upon the results of the use of an "ash-burning" compound the New York Board of Education states that fifty thousand dollars worth of coal has been saved, and this saving is credited to the use of the compound. As proof that the alleged saving was actual, we have the published testimony of the honorable gentlemen composing the Board and also a description of the mental process by which the amount of actual saving was determined. It was *assumed* that 107,288 tons of coal would have been burned had not the compound been used, but owing to the coöperation of the janitors and the intelligent use of the compound by the firemen under the direction of the members of the Board, who had become expert firemen and experienced in the use of the compound, only 98,675 tons of coal was used; a clear saving of 8613 tons of good coal. It is manifest that an item of such importance should not be neglected, nor should the taxpayers of New York be allowed to remain in ignorance of the patient, painstaking, faithful service that is being given by the scientific gentlemen of the Board of Education, who were getting billions of heat units out of a substance in which no heat units existed, had defied and overthrown the laws of chemistry, burned the incombustible and covered blatant professors of natural science with shame.

Just why fifty thousand dollars should be selected for the price of the 8613 tons of coal alleged to have been saved is, however, not so clear as it might be. It amounts to a fraction of a cent over $5.80 per ton, which would, to an ordinary mortal, seem to be a rather long price to pay for coal when used at the rate of over 4000 tons per week. In fact, it would seem that if an amount of energy and enthusiasm equal to that expended in forcing engineers, janitors and firemen to use worse than worthless nostrums against their own good judgment had been directed toward the design of suitable furnaces, the study of methods of heating and ventilation, and the purchase of coal for use in the schools on a strictly business basis, a saving much larger than that *guessed at* by the New York Board of Education would have been effected.

A Field for the Large Isolated Plant

The tendency of the times seems to be toward consolidation and the merging at one common center of the executive and producing departments of various interests. This applies particularly to electric-light and power stations which a few years ago had a meager beginning, but which gradually absorbed the smaller isolated plants, or put them out of business by selling electricity to their owners cheaper than they could produce it themselves.

The reason for this is not difficult to find. There are thousands of isolated plants that cannot compete with the central-station rates because of the fixed expenses, which are much too high in proportion to the output of the plant. For instance, a power building requiring 3500 kilowatts maximum capacity with an average load of 2500 kilowatts will require at least one chief engineer, two assistant engineers and two firemen, as the plant would necessarily operate day and night. If the plant were doubled in capacity the fixed operating expense would be but slightly greater, while the output would be double. It is this overhead expense that prevents the small isolated plant from producing a kilowatt-hour as cheaply as the central station. Considering merely the coal consumption per kilowatt-hour,

there is no reason why an isolated plant of considerable size cannot produce a kilowatt-hour as cheaply as the largest central station. Eliminating the high overhead charges, it should be able to produce a kilowatt-hour more cheaply, because there is not the heavy first cost of line construction, nor constant additional cost for line maintenance, to say nothing of line losses.

The owners of isolated power plants in the past, apparently losing sight of the fact that they are not confined to supplying current for one particular building, have been content to operate their plants at a greater cost, if the truth be known, than the price of the same amount of energy from the central station. They have lost sight of the fact that if consolidation and concentration are good for the large power producers they are good for the smaller ones also. Only a few owners of isolated plants have awakened to the fact that there is money to be made in supplying neighboring plants with electricity, that where before they were merely making both ends meet in regard to operating expenses, such additional business is practically clear gain. As power can be sold under such circumstances much lower than the price that a central station would quote to a small power user, there is no trouble in obtaining as many customers as the plant can supply.

Not only is there a market for the electricity generated, but in the winter months the exhaust steam can be sold for heating purposes at rates that will appeal to those who are obliged to bear the heavy expense of operating a heating plant.

Different Kinds of Direct Current

Power-plant men generally have a well defined understanding of the elementary nature of alternating current—they know that its direction or "polarity" reverses continually at regular but very brief intervals. It is safe to assume, however, that comparatively few practical workers realize the distinctions between the different kinds of direct current. The terms "direct" and "continuous" are commonly used with the same meaning, although there are two kinds of direct current which are not continuous.

Any current that does not alternate in its direction of flow is "direct" current. The term "direct" is merely a short substitute for "unidirectional," meaning in one direction.

The character of a current flowing through a simple resistance is determined entirely by the character of the electromotive force which produces it. A steady electromotive force, such as that of a battery, will produce a steady or "continuous" current; a pulsating electromotive force will produce a pulsating current, and so on. Outside interference, however, can change the character of the current very greatly. For example, a storage battery connected to a constant resistance will yield an absolutely steady or continuous current; the strength will decrease very gradually as the battery discharges, but the current will be continuous. If, however, a storage battery be connected to an induction coil of the usual vibrator type, the current will be intermittent, because the vibrator or "trembler" opens and closes the circuit successively.

The electromotive force of any direct-current dynamo having a commutator is more or less pulsating or varying. Consequently, it is impossible to get a perfectly steady current from a commutator machine. The more commutator bars there are, the less pulsating will the current be, but it is impracticable to use enough commutator bars to smooth out the pulsations entirely. Hence, it is not correct to call an ordinary dynamo a continuous-current machine. The word continuous is used in this connection to mean "steady," as contrasted with pulsating currents, and applies only to the current supplied by a battery or a homopolar* dynamo when connected to a constant resistance.

Summing up, then:

The current from a commutator dynamo is necessarily pulsating and not continuous in the electrical sense.

The current from a battery or a homopolar dynamo is continuous, unless some external influence interferes with its flow.

"Continuous" and "pulsating" currents are both "direct," because they are not alternating.

*Sometimes called "unipolar," but erroneously. It is impossible to produce only one magnetic pole.

A Needless Loss of Life

The ink was hardly dry from writing our editorial on "The Criminality of Operating Defective Apparatus," which appeared in the August 11 number, when we received word of the disastrous boiler explosion at York, Penn., a full account of which appears on another page of this issue. What was then said regarding defective apparatus seems mild when considering the harvest of death due to this boiler explosion, for which not an iota of excuse can be found.

Ten skilled mechanics torn, broken and mutilated; six women widowed; a dozen children fatherless; an aged woman's only support taken from her; and for what? Only that an old wornout, abused, burnt and cracked boiler might still do service and thus save the expense of a new one. Small wonder that the officials of the Susquehanna Iron and Steel Company deeply feel this fearful disaster that has befallen them, not only as men feel one for another in times like this, but as members of a company who must feel the guilt of having permitted a boiler to be operated in such a deplorable condition as that of the exploded boiler. It matters not what statement the company may make, it matters not what verdict the coroner's jury may arrive at, it matters not if the blame for the disaster be thrown upon the shoulders of the fireman, it matters not what the employees of the works may say to the contrary regarding the rotten condition of the boiler, the boiler was not in a safe condition to operate. We make this statement positively on the strength of actual inspection of the remnants.

It seems hardly credible that men living in this age of progress, endowed with intelligence and surrounded by every factor for procuring safety within the power of human agency, would permit a steam boiler to operate without a reliable steam gage attached, and nothing can be more ridiculous than the assertion made by an official of the company that the cause of the explosion is "unaccountable."

If it could be conceded that a steam gage on a boiler is not necessary, and that the safety valve is a sufficient means of determining the steam pressure carried, it goes without saying that that safety valve should be *known* to be in perfect operating condition. A safety valve that has been known to blow off but once in eighteen years, according to statements made by those who know, can hardly be called a safety valve. This is still more evident when the unreliability of the ball-and-lever safety valve is considered, which was the type with which the boiler was equipped.

Even waiving the necessity of the steam gage and the known unreliability of the safety valve, the facts still indicate with unmistakable directness the most flagrant neglect of precautions to maintain the safe condition of the boiler. Although it is claimed that the boiler was safe, and only recently repaired and inspected by an expert inspector, the wreck showed anything but a safe condition. With cracks in the plates which must have been disclosed had a careful inspection been given the boiler; pitted, corroded and burnt plates, which none could fail to detect; with plates wasted away to one-sixteenth of an inch in thickness in places—such a boiler cannot be considered anything short of a menace to life and property, and its operation should have been prohibited long ago. Whether the officials knew of this condition, we know not; if they did not, they should have known, or at least have had the boiler under the control of some responsible person whose business it was to know and, furthermore, to keep it in a safe condition, if that is possible of a second-hand boiler after eighteen years of hard, abusive service.

There is no mystery as to the cause of the explosion. Nothing else could be expected of a boiler operated in such a state.

Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

Lincoln Variable-speed Direct-current Motor

The accompanying engravings illustrate a somewhat unusual type of variable-speed direct-current motor which has been brought out by the Lincoln Motor Works Company, Cleveland, Ohio. Changes of speed are produced by changing the magnetic circuit of the machine so as to weaken or strengthen the magnetic field, and this is done by means of a hand-wheel located at the pulley end of the motor, as shown in Fig. 1. Turning this wheel moves the armature endwise and thereby alters the air-gaps between the armature core and the field-magnet pole-faces.

The sectional view, Fig. 2, shows the constructional details of the machine. The end of the armature shaft on which the commutator is mounted revolves in a ball bearing located in a sleeve which fits slidably in the journal bracket. This sleeve is moved back and forth by a forked lever which is controlled through a rod and nut by the screw on the spindle of the hand-wheel. The helical spring surrounding the rod pivoted to the curved lever is for the purpose of balancing the magnetic pull which the field-magnet poles exert on the armature core.

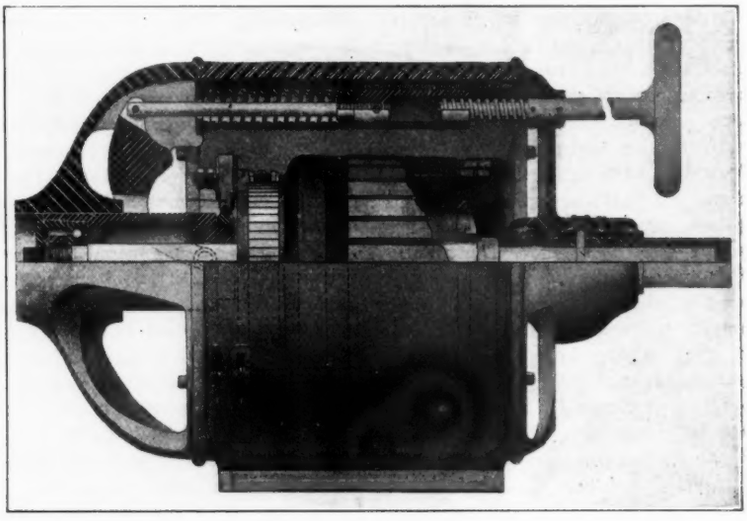


FIG. 2. SHOWING ARRANGEMENT OF ARMATURE SHIFTER

The armature core is slightly tapered, the end next to the commutator being smaller in diameter than the other end, and the faces of the field-magnet poles are bored to a corresponding taper. Consequently, when the armature is drawn to the right (as Fig. 2 shows the machine), the air gaps are increased in length as well as decreased in area, and it requires a relatively small displacement of the armature to produce a large difference in the magnetic field. Weakening the field increases the speed, and *vice versa*. Sparking at the brushes, when operating at high speeds, is prevented by means of small intermediate field-magnet poles located nearer than are the main poles; as the armature is drawn outward, weakening the main field, it comes within the influence of the auxiliary poles, which supply a commutating field.

The brush-holder quadrant is mounted on the end of the sleeve containing the ball bearing, and therefore moves back and forth with the armature and commutator. The ball bearing serves as both

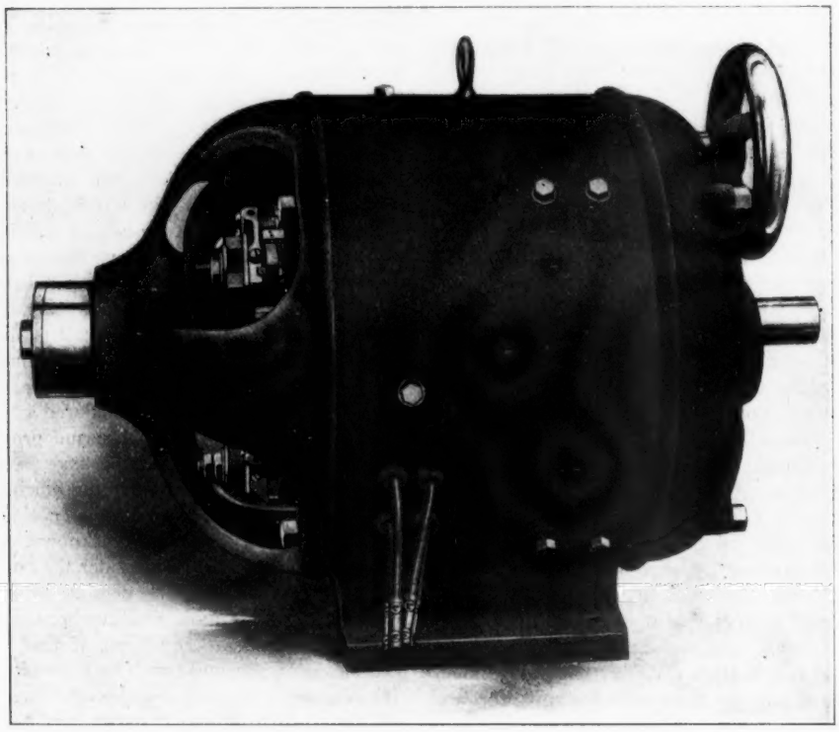


FIG. 1. LINCOLN VARIABLE SPEED ELECTRIC MOTOR

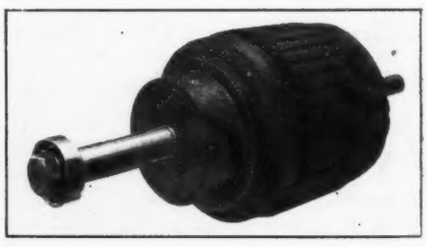


FIG. 3. ARMATURE OF LINCOLN MOTOR

a radial and a thrust bearing for the armature shaft.

The driving end of the shaft slides within a sleeve which revolves with it but does not slide endwise; this sleeve is lubricated by an oil ring, just as the shaft would be if it did not slide back and forth; the driving pulley, gear or coupling is mounted on the end of the sleeve.

The armature is of the usual slotted-core type, equipped with form-wound and individually insulated coils. Fig. 3 shows the complete armature and commutator, with the ball bearing at the commutator end of the shaft.

speed being 470 revolutions per minute and the maximum 1880.

The machines are built in sizes ranging from ¼ to 30 horse-power and with speed ranges as great as ten to one and as small as one desires. All of the machines are of the circular type shown in Fig. 1.

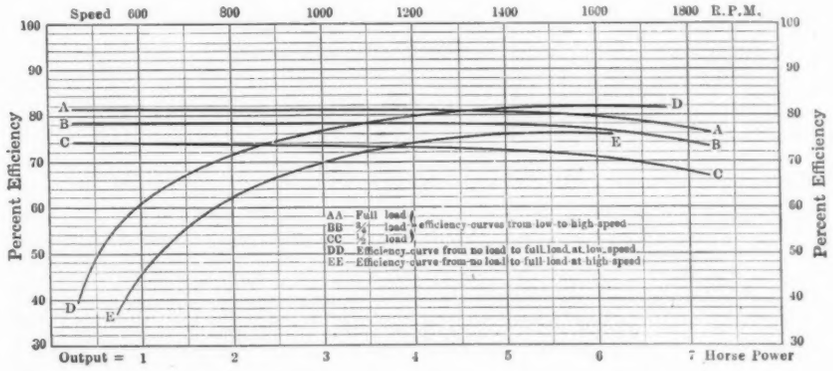

Speed 600 800 1000 1200 1400 1600 1800 R.P.M.
Percent Efficiency
Output = 1 2 3 4 5 6 7 Horse Power
AA—Full load
BB—¾ load
CC—½ load
efficiency curves from low to high speed
DD—Efficiency curve from no load to full load at low speed
EE—Efficiency curve from no load to full load at high speed

FIG. 4. SPEED-EFFICIENCY CHART FROM 5-HORSEPOWER MOTOR

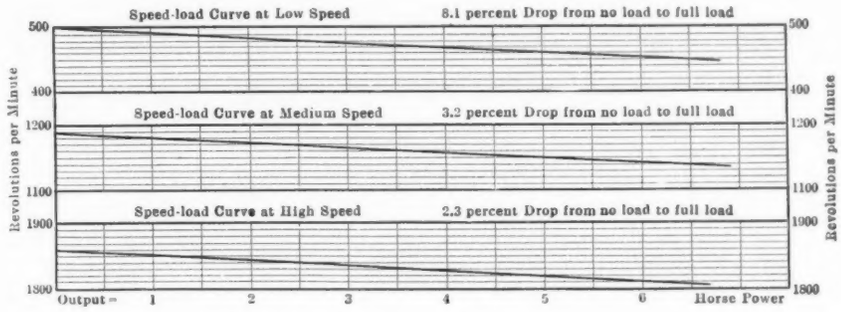

Speed-load Curve at Low Speed
8.1 percent Drop from no load to full load
Speed-load Curve at Medium Speed
3.2 percent Drop from no load to full load
Speed-load Curve at High Speed
2.3 percent Drop from no load to full load
Revolutions per Minute
Output = 1 2 3 4 5 6 Horse Power

FIG. 5. SPEED-LOAD CHART FROM 5-HORSEPOWER MOTOR

Figs. 4 and 5 are speed-efficiency and speed-load charts plotted from a test of a 5-horse-power motor having a speed range of four to one, the minimum rated

A Hand Tachometer

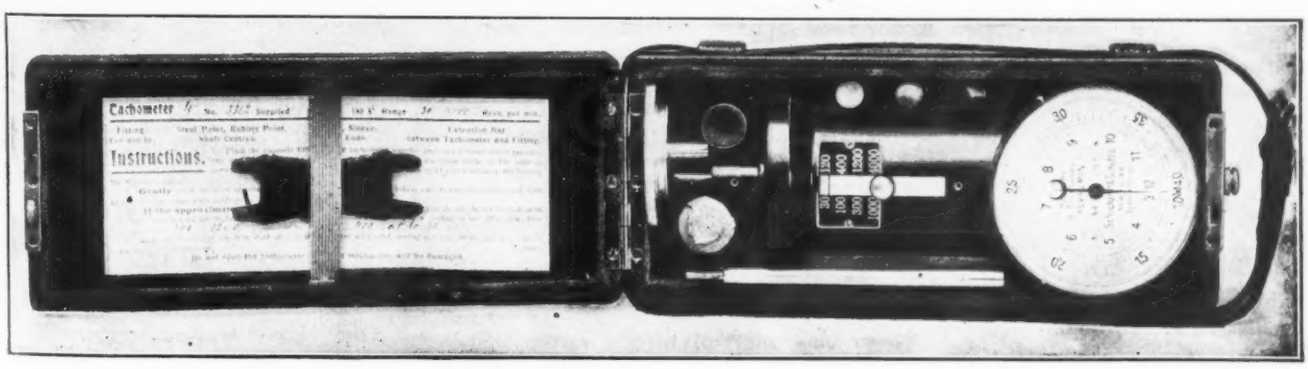
The hand tachometer now being supplied by Schuchardt & Schutte, 136 Liberty street, New York City, is shown in the accompanying illustration. This instrument indicates on a dial the number of revolutions a shaft is making, also all measurements of rotative speeds.

This tachometer is based on the action of centrifugal force on weights pivoted on a rotating spindle. The movement of these weights, when rotating, is controlled by gravity, or by springs, and is indicated by a pointer mechanically connected to them. The pointer, therefore, at any moment indicates the position of the rotating weights. The pointer gear is provided with an efficient damping action, which does not affect the accuracy of the readings, but insures a steady movement of the pointer.

The advantages of this type of tachometer are that the readings are independent of the duration of the test and can be read on the dial of the instrument without using a watch. The instrument indicates instantaneously the smallest speed variations occurring during a fraction of a minute and is independent of the direction in which it is driven. To render it universally applicable, the instrument is supplied with suitable accessories, viz, triangular steel points, rubber points and funnel centers, extension bar for the spindle and disk pulley. The disk pulley is used for determining belt, rope and periphery speed. A V-shaped groove is turned in the edge of the disk pulley or measuring wheel, and where shafts are not easily accessible, the measuring wheel can be driven by a thread which is passed round the shaft and runs in the groove of the measuring wheel. One spindle serves for all ranges, but the change from one speed range to another can be effected while the tachometer is in use, the cut across the thumb-nut slider showing the range in use.

A 50-watt incandescent lamp gives off 170 B.t.u. per hour.

The Civil Service Commission of New York, headquarters at Albany, announces examinations of applicants for the position of fireman in the Department of Public Buildings at Albany (salary, $720), in the county service of Albany, Erie, Monroe, Onondaga and Westchester counties and elsewhere. Application blanks should be filed in the office of the commission before noon of August 29.



HAND TACHOMETER AND CASE

Inquiries

Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.

How to Find the Horsepower of an H. T. Boiler

How shall I find the horsepower of a horizontal tubular boiler 44 inches in diameter and 12 feet long, with forty-six 2¼-inch tubes?

J. L. B.

The circumference is:

$$\frac{44 \times 3.1416}{12} = 11.519$$

feet. Since the boiler is 12 feet long, the area of the entire shell, i.e., the product of the length by the circumference, would be:

$$\frac{44 \times 3.1416 \times 12}{12} = 138.23$$

square feet, and if 2.3 of this is between fire and water, the heating surface in the shell will be:

$$\frac{44 \times 3.1416 \times 12 \times 2}{12 \times 3} = 92.1536$$

square feet.

A 2¼-inch tube has 0.5393 square foot of heating surface per foot of length (see "POWER Catechism," page 100). You have 46 tubes each 12 feet long. The tube-heating surface is, therefore:

$$0.5393 \times 46 \times 12 = 297.6936$$

square feet. The cross-sectional area of a 2¼-inch tube is:

$$2.25^2 \times 0.7854 = 3.975$$

square inches, or:

$$\frac{2\ 25^2 \times 0.7854}{144} = 0.0276$$

square foot. There are 46 of these holes in each end, or:

$$46 \times 2 \times 0.0276 = 2.539$$

square feet to be deducted from the area of the heads below the water line. The usual practice is to deduct it from the area of one head, which would in this case be:

$$\frac{44^2}{12} \times 0.7854 = 10.5,$$

or:

$$\frac{44 \times 44 \times 0.7854}{12 \times 12} = 10.559$$

square feet. Deducting the tube holes from this area:

$$10.559 - 2.539 = 8.02$$

square feet in the heads. Adding these we have:

	Square Feet.
In the shell	92.1536
In the tubes	297.6936
In the heads	8.0200
	397.8672

Allowing 12 square feet per horsepower, the boiler would rate at:

$$\frac{397.8672}{12} = 33.15$$

horsepower.

Figuring Speed

I am desirous of knowing a practical way of figuring speed, or the simplest. If convenient, let me have one or more formulas.

C. G.

Multiply the diameter of the driving pulley by its revolutions per minute. Divide this product by the diameter of the driven and it will be the speed of the driven. Divide this product by the desired speed of the driven and it will be the diameter of driven required. Work it for the driver by using the product of the diameter and speed of the driven in the same way.

d = Diameter of driver,
D = Diameter of driven,
r = Revolutions per minute of driver,
R = Revolutions per minute of driven.

$$d\,r = D\,R,$$

$$d = \frac{D\,R}{r} \quad D = \frac{d\,r}{R},$$

$$r = \frac{D\,R}{d} \quad R = \frac{d\,r}{D}.$$

Oxygen Consumed in Burning Carbon, etc.

If I put one pound of carbon in a vessel containing 10 cubic feet of oxygen at 15 pounds pressure, what part of the oxygen will be consumed if the carbon is burned? What is the volume of the gas after combustion, temperature and pressure being kept constant?

J. D.

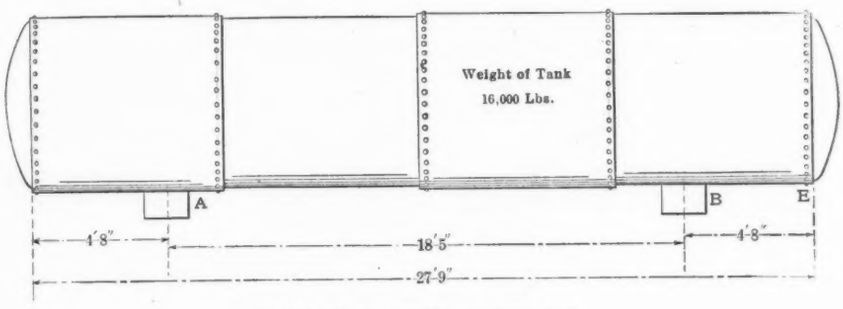
One pound of carbon requires 2.66 pounds of oxygen to form CO_2. Ten cubic feet of oxygen at 15 pounds gage pressure would weigh 1.785 pounds, so there would not be enough oxygen to combine with all of the carbon, only 0.671 pound of carbon being necessary to consume the oxygen in the vessel. This amount of carbon, 0.671 pound, burning with the given amount of oxygen would form 2.456 pounds of CO_2, and as CO_2 weighs 0.123 pound per cubic foot of atmospheric pressure, the resulting gas would have a volume of 20 cubic feet of atmospheric pressure or 10 cubic feet at 15 pounds gage pressure, which is exactly the same volume as the contents of the vessel before combination.

Weight Lifted by Jack

In the sketch, A and B are the saddles upon which the tank, weighing 16,000 pounds, is resting. If a jack is placed at E what weight will it have to lift to clear the saddle B?

R. T. M.

This is simply a question of leverages and is solved by the same method that would be used in a safety-valve problem.



TANK TO BE LIFTED AT ONE END

The tank weighs 16,000 pounds and its center of gravity is 9.21 feet from the fulcrum A. The jack placed at E is 23.08 feet from the fulcrum A; therefore:

$$\frac{9.21 \times 16{,}000}{23.08} = 6384.7$$

pounds weight to be raised by the jack placed at E.

Salt Needed for Brine in an Ice Tank

How much salt will it take to make brine for an ice tank, and what kind is best?

L. W.

The amount of salt required to make brine for an ice tank of a given capacity is subject to more or less wide variations on account of the diversity of designs used by the different builders. As the amount of space left between the bottoms of the cans and the tank is often subject to quite wide variations, it might be well to figure out the specific problem in mind, allowing 15 pounds of salt per cubic foot of brine actually required to fill the tank when the cans are in place. A rough estimate is 2/3 tons of salt per ton of ice-making capacity of tank per twenty-four hours.

Use the cheapest salt you can get.

During a thunderstorm at Szegedin, Austria, on August 8 a tall chimney which had just been erected fell on a partially built structure adjoining, on which one hundred men were at work, killing seven and wounding thirteen.

Book Reviews

MECHANICAL ENGINEERING AND SHOP PRACTICE. By Stanley H. Moore. Hill Publishing Company, New York and London. Cloth; 502 pages, 6x9 inches; illustrated. Price, $4.

This is a work by an instructor and is intended to be a complete and practical manual for the guidance and instruction of apprentices and younger men in the shop; while by the older workmen it may be used as a ready and easy means of reference for information in every department of work; for in its scope it covers tools, machines, processes and materials, mechanics, generation and transmission of power, engines, turbines and motors, shaft, belt and rope transmission.

In the preparation of the work the point of view of the student and apprentice was kept constantly in mind, a large proportion of it being matter written in direct answer to actual questions asked by students and apprentices, while receiving instruction in machine-shop work, and having a thoroughly practical bearing on the subjects to which reference is made. Much of the matter has already been published in the *American Machinist*, *Machinery*, POWER and other prominent mechanical periodicals. Some of the text consists of extracts from papers presented at the meetings of the American Society of Mechanical Engineers, which have been widely copied by the European technical press. One unique feature of the work is the number of classifications in the table of contents, which tell at a glance the chapter, the classification and the section to which the subject belongs. Illustrations are numerous and are numbered to match the sections to which they pertain; they consist of tables, line drawings or half-tones, as the text requires. Above two thousand sections are included in the index, which furnishes a means of speedy reference to the subject and adds to the peculiar value which the work will have for those for whom it was written.

HYDRAULICS. By F. C. LEA. Published by Longmans, Green & Co., New York, 1908. Cloth; 547 pages, 5x8½ inches; 367 illustrations. Price, $5.

This is a most comprehensive treatise, essentially didactic in character. It was prepared for use as a college textbook, and should serve that purpose admirably. The discussion of the elementary principles of hydrostatics and hydraulics is very full without being verbose, and the chapters devoted to the different types of hydraulic prime mover are the best that the reviewer has found. As a reference book for engineers it is perhaps too detailed to be convenient; to students who do not readily follow mathematics as high as the calculus it is useless. For college purposes it is finely adapted. The reviewer has not attempted to check the mathematics except in a few places where this could be done expeditiously; in all such cases the author has been found accurate, excepting on page 82, where the symbol H has been omitted between 1 and N in the first formula, and on page 309, where the equation for the quantity of water flowing through a wheel is made proportional to the cotangent instead of the cosine of the angle between the velocity vectors BK and BF, of Fig. 194. These errors are so obvious, however, that it is only fair to ascribe them to hasty copying or to careless typographical composition.

POWER GAS PRODUCERS. By Philip W. Robson. Published by Edward Arnold, London, Eng., 1908. Cloth; 250 pages, 5½x8½ inches; 105 illustrations; 27 tables. Price, $3.

As might have been expected by reason of the author's experience in the design and construction of gas producers, this book contains a great deal of reliable information about producer principles and excellent advice as to operation. The work is divided into three sections, the first devoted to simple suction producers, the second to pressure plants for non-bituminous fuel and the third to bituminous coal. The explanation of the general fundamental principles of coal gasification is unusually clear—in spots unnecessarily elementary — although the author occasionally lapses into indirectness of statement and frequently splits infinitives needlessly. The remarks on the design of producers are so uniformly restricted to bare generalities that the reader cannot escape the conviction that the superficiality is intentional; Mr. Robson certainly knows vastly more than he tells of this phase of the subject. The advice as to the care and management of producer plants is very satisfying. The descriptions of apparatus are perfunctory, except as to the product of the company with which the author is connected.

HANDBOOK OF MATHEMATICS FOR ENGINEERS. By L. A. Waterbury. Published by John Wiley & Sons, New York. Flexible morocco; 91 pages, 5½x2¾ inches. Price, $1.

This is a vest-pocket book, rather than a handbook, recording in a concise form those memoranda which a student would naturally make in blazing his way across the field of higher mathematics, and those memoranda which the civil engineer would find useful when away from access to his books of reference. It treats of Algebra and Logarithms, Trigonometry, Analytic Geometry, Differential and Integral Calculus, Theoretical Mechanics and the Mechanics of Materials, nearly half of the book being devoted to the last-named.

Books Received

"Electrical Contracting." By Louis J. Auerbacher. McGraw Publishing Company, New York. Cloth; 155 pages, 5x8½ inches; 225 illustrations; indexed. Price, $2.

"The Plane Table." By W. H. Lovell. McGraw Publishing Company, New York. Cloth; 47 pages, 4¾x7¼ inches; indexed. Price, $1.

"Curves for Calculating Beams, Channels and Reactions." By Sidney Diamant. McGraw Publishing Company, New York. Sixty-three pages, 10x7 inches, including 25 page plates, tables and illustrations. Price, $2.

"Drawing Instruments." By Walter G. Stephan. McGraw Publishing Company, New York. Cloth; 111 pages, 4½x7¼ inches; 75 illustrations; indexed. Price, $1.

"Economy in Lubrication" is the title of a 26-page pamphlet written by W. A. Mayes, of Reading, Penn. It is an endeavor on the part of the author to counteract what he calls erroneous belief on the part of many that grease is an economical lubricant. Most of the text is given to arguments on the superiority of oil as compared with grease. Charts, indicator diagrams and pictures, supplemented with reports of three comparative tests and the conclusions drawn therefrom, are used to substantiate the claims of the advocate. As an example of special pleading it is entitled to a high rank. It is well written, abounds in marginal notes and references, is printed in two colors, is pleasant reading, and can be had by addressing the author at 617 Church street, Reading, Penn.

Personal

Samuel Hildreth, formerly with the Crandall Packing Company, is oscillating between Brooklyn and Milwaukee, in charge of the packing department of the H. W. Johns-Manville Company.

It sometimes happens with a single-valve automatic engine that on a very light load the compression gets to be so high that it goes above the boiler pressure, causing the valve to lift from the seat and clatter badly. The remedy for this is either to drop the steam pressure or else pinch down on the throttle. The writer has known a Corliss engine to act in the same way, that is, the valves would clatter, but from a different cause—here the trouble was that it was expanding down below the atmospheric pressure, so as to produce a partial vacuum in the cylinder.

Government Oil Specifications

Following are the specifications of the Government for oil to be used in public buildings:

Cylinder Oil, No. 1—High-pressure cylinder oil, for use in high-pressure cylinders. To be a mixture of pure mineral, hydrocarbon cylinder-oil stock and acidless animal oil, tallow oil being preferred. It must contain not less than 3 per cent. or more than 7 per cent. of pure, acidless, animal oil, and have a flash point of not less than 600 degrees Fahrenheit; a fire test not below 650 degrees Fahrenheit; a cold test below 55 degrees Fahrenheit; a gravity between 25 and 27 degrees Baumé at 60 degrees Fahrenheit.

Cylinder Oil, No. 2—Low-pressure cylinder oil, for use in low-pressure cylinders. To be a mixture of pure petroleum cylinder stock and acidless animal oil, tallow oil being preferred. It must contain not less than 10 per cent. of pure, acidless, animal oil, and have a flash point of not less than 550 degrees Fahrenheit; a fire test not below 600 degrees Fahrenheit; a cold test below 40 degrees Fahrenheit; a gravity between 25½ and 27½ degrees Baumé at 60 degrees Fahrenheit.

Machine Oil—To be a free-running, filtered, bright, hydrocarbon oil. It may contain not more than 10 per cent. of acidless neatsfoot or tallow oil. Combined oil to be free from alkali or acid. Flash point to be not less than 435 degrees Fahrenheit; fire test not less than 500 degrees Fahrenheit; gravity, about 25 degrees Baumé. It must be practically free from liability to absorb moisture and have a loss in weight of less than 0.5 per cent. upon heating at 250 degrees Fahrenheit for four hours.

Dynamo Oil—To be a free-running, hydrocarbon oil. May contain not more than 5 per cent. of tallow or neatsfoot oil (acidless). Combined oil to be free from alkali or acid. Flash point not less than 420 degrees Fahrenheit; gravity about 28 degrees Baumé.

The foregoing described oils must be free from all adulterations or mixture with animal, vegetable, or fish oils, grease, lard, or tallow, except as stated, and contain no tarry or suspended matter, acid or alkali, glue or water.

METHODS TO BE USED IN TESTING THE OILS

Flashing point and burning tests—Heat a small quantity of the oil in an open vessel, not less than 12 degrees Fahrenheit per minute, and apply the test flame every 10 degrees Fahrenheit, beginning with 250 degrees Fahrenheit.

Precipitation test for tarry and suspended matter—Pour 95 cubic centimeters of 88-degree Baumé gasolene into a 100-cubic centimeter glass-stoppered, graduated cylinder. Add 5 cubic centimeters of the oil to be tested. Shake thoroughly and allow to stand ten minutes. With satisfactory oil no precipitation will occur.

Test for adulteration, saponification—This test depends on the property that mineral oils possess of *not* forming an emulsion when treated with alkali.

Treat a weighed sample (about 5 grams) of the oil in a flask with an alcoholic solution of caustic soda or potash, the flask being kept on the water or steam bath for about one hour, or until saponification is effected. Then evaporate off the alcohol and dissolve the soap in boiling distilled water.

Allow the flask to cool, remove the contents to a separating funnel, and agitate with petroleum ether. As soon as the liquids have separated, draw off the aqueous layer and wash the ether layer twice in the separator with water, drawing off the water solution as before, but not mixing these washings with the first aqueous solution, which should be treated again with a fresh amount of petroleum ether.

Then run the ether solutions into a weighed flask; evaporate off the ether and weigh the flask and residue.

The difference between this last weight and that of the empty flask is the weight of unsaponifiable matter in the original sample of oil.

Volatility—Kept heated to 400 degrees Fahrenheit, in an open vessel, it must not lose more than 5 per cent. of its weight in six hours.

To test for mineral acid or alkali—It will be sufficient to wash a small quantity of the oil with warm, distilled water, then drain off the water and test it with methyl orange.

To test for free fatty acids—Heat to boiling 5 grams of the oil with 50 cubic centimeters of neutral, 95-per cent. ethyl alcohol. Titrate acidity with one-half normal solution of caustic potash using phenolphthalein as an indicator.

Specific gravity will be determined by the use of specific gravity bottle (Geissler's, or similar design).

At a recent meeting of the Society of Chemical Industry, Dr. C. A. Keane and Dr. H. Burrows described their experiments with the "autolysator," an apparatus for the automatic estimation of carbon dioxide, devised by Strache, Johoda, and Cenzkin, which differs from all other forms of automatic analyzer in giving a continuous, instead of an intermittent, record of the carbon dioxide content of the furnace and other gas examined. The gases were drawn continuously through reservoirs containing soda lime, and the diminution in pressure caused by the absorption of the carbon dioxide was recorded at any instant by specially constructed differential manometers. The results showed that the records agree within 0.3 per cent. with those obtained by ordinary methods.

Business Items

The Buckeye Boiler Skimmer Company, South End, Toledo, Ohio, has received a letter from the Wafakoneta Wheel Company, of Wafakoneta, Ohio, which recently installed one of these skimmers in its boiler, and the letter says that the skimmer is doing excellent work and they are well pleased with it.

The Hubbard & Palmer Company, of Mankato, Minn., has awarded a contract to the Minneapolis Steel and Machinery Company for a 10x30" Twin City Corliss engine, a 60-inch by 16-foot horizontal return-tubular boiler, a feed-water heater and purifier and a boiler-feed pump, etc., for its new cleaning house and elevator at Kasota, Minn.

The managing director of Smith Bros., Leicester, England, is arranging for an American trip this fall and wishes to get in touch with manufacturers of engineering specialties, tools and other mechanical equipment, with a view to English sales being taken charge of by them. Information may be had by addressing Smith Bros., Batten Street, Aylestone Park, Leicester, England.

A machine-shop and foundry building is under construction for the Goldschmidt Thermit Company, of 90 West street, New York City. It occupies a site 34x90 feet in size just back of the present factory in Jersey City, and is to be fitted up for the purpose of handling to better advantage the extensive repair work which is now being carried on at these works. Traveling cranes will be provided.

The Ohio Blower Company, of Cleveland, reports more orders in June and July than during the same months of any preceding year. This company commenced its weekly advertisement in the May 5 number. Its cast-iron exhaust heads are finding a large field in gas-engine practice, where their use permits a more generous spraying of water into the exhaust, avoids unpleasant and unsightly discharges therewith, and greatly reduces the noise thereof by serving as a muffler.

The constantly increasing trade of the S. Obermayer Company in and around Erie, Penn., has made it necessary for the company to open a branch warehouse in that city. W. L. Scott, well known to the foundry trade in that section, is in charge, and a full line of foundry facings, core compounds, plumbago and blackings will be carried for the present; and just as soon as conditions warrant, a complete line of other foundry facings and foundry supplies will be carried in stock there.

The Buckeye Boiler Skimmer Company, South End, Toledo, Ohio, has received a letter from George W. Moyer, engineer of the Mosier laundry, Lima, Ohio, in which he says: "I think the Buckeye floating skimmer is the finest thing that was ever put on a boiler. I clean my boilers every four weeks now, and don't get mud enough to make a mark with my finger. I blow the precipitator every hour, and the skimmer does the rest. I have been an engineer for thirty-three years and I have never found anything near its equal."

A booklet of envelop size, entitled "Dixon's Ticonderoga Flake Graphite," has been received from the Joseph Dixon Crucible Company, of Jersey City, N. J. It is printed in black and red. The text is arranged so that at the bottom of each page is given a testimonial bearing, whenever possible, on the particular phase treated on that page. Anyone who is interested in machinery of any sort will probably find in this booklet some matter of interest. Some valuable information is given in it and any of our readers desiring a copy may secure it by writing directly to the Dixon company.

The C. O. Bartlett & Snow Company, of Cleveland, reports that it is in receipt of an order through F. C. Greene, of Cleveland, Ohio,

You Can Trust "The American" Special Pop Safety Valve To Blow Off Exactly At The Right Point. ∴ ∴ ∴

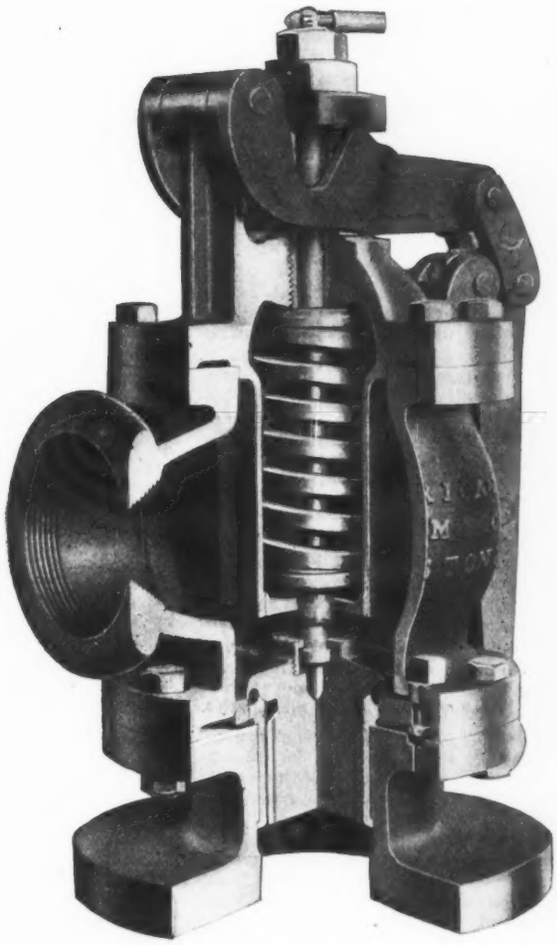
The American Special

¶ Has a greater capacity for blow-off than any other.

¶ Is prompt and positive in action, carefully tested and fully guaranteed, and made extra heavy to withstand high pressures.

¶ Can always be depended upon to blow-off at the right pressure.

ASK FOR CIRCULAR 1-D



If your jobber does not carry "The American" specialties and will not procure them for you, we will ship to you direct from our factory.

American Steam Gauge & Valve Mfg. Co.

208-220 Camden Street, Boston, Mass.

New York, 26 Cortlandt. **Atlanta, 835 Equitable Bldg.** **Chicago, 7-9 So. Jefferson Street.**

Pittsburg, Frick Bldg. Annex.
Montreal, 444 St. James Street.
San Francisco, 247 Pine Street.
Los Angeles, 213 So. Los Angeles Street.

mining engineer for the Crow's Nest Pass Coal Co., Fernie, B. C., for a complete steel tipple for the company's Michel mines. The tipple is to have a capacity for handling 6000 tons coal per eight-hour day. A Greene self-dumping car haul will be installed, as well as other of the engineer's special appliances, together with special machinery manufactured by the C. O. Bartlett & Snow company. Considerable of the machinery will be purchased in Canada, and work will be pushed to completion by the first of January, 1909. This plant is said to be of the largest capacity of any single tipple in North America.

The Trill Indicator Company, of Corry, Penn., confident that the country is on the verge of a business boom, has taken time by the forelock and made preparations by building a large addition to its factory. The company has been running full time and full handed during all the past winter and summer months, and has recently increased its force, with many orders ahead. Following is a partial list of recent sales: Youngstown Consolidated Gas and Electric Company, Youngstown, Ohio; Knight & Wall, Havana, Cuba; California Polytechnic School, San Luis Obispo, Cal.; Thompson & Ford Lumber Company, Sour Lake, Tex.; Corry Electric Light Company, Corry, Penn.; Warren Light and Power Company, Warren, Penn.; F. Hauber, Brünn, Austria; Miles A. Hoffman & Co., London, England; New England Company, Cleveland, Ohio; Holdrege Lighting Company, Holdrege, Neb.; Risley Brothers & Co., Jacksboro, Tex.; N. A. S. E. No. 5, Cleveland, Ohio.

The Youngstown Sheet and Tube Company, Youngstown, Ohio, has contracted with the William B. Scaife & Sons Company, Pittsburg, Penn., for an addition to the present 15,000-horsepower water-softening and purifying system to provide for the 8000-horsepower boilers which are being added for the operation of the new blast furnaces. The present water-softening and purifying system is of the "We-Fu-Go" intermittent type, and consists of four large treating and settling tanks and four mechanical gravity filters When the additional apparatus is installed, the system will consist of six large treating and settling tanks and seven mechanical gravity filters, and the total capacity will provide for 23,000 horsepower of boilers, or 92,000 gallons of water per hour. Other recent contracts taken by the William B. Scaife & Sons Company are the following: Tennessee Coal, Iron & Railroad Company, 35,000 horsepower; Shenango Furnace Company, 8,000 horsepower; American Steel & Wire Company, 25,000 horsepower; Woodward Iron Company, 10,800 horsepower.

Among recent orders taken by the Ohio Blower Company, Cleveland, Ohio, for "Swartwout" steam specialties are the following: One 12-inch steam separator for the Sloss Sheffield Steel and Iron Company, Florence, Ala., in addition to a previous order for three 10-inch separators; one 10-inch separator for the Lakeside Hospital, Cleveland, Ohio; an exhaust head, steam and oil separator for the New York Central railroad shops; a 6-inch oil separator and exhaust head for the Northern Electric Company, Newport, Wash.; one 10-inch, 8-inch and four other sizes of exhaust heads for the John R. Kehm Company, Battle Creek, Mich.; steam separators for the Grand Trunk railroad shops, Battle Creek, Mich.; and for the James Flood building, San Francisco, Cal.; exhaust heads to the Stillwater State prison, Stillwater, Minn., and the Brooklyn Union Gas Company, Brooklyn, N. Y.; exhaust heads for the Pana high school building, Pana, Ill.; high school building at Beloit, Wis.; the East high school, Minneapolis, Minn.; the Lincoln school building, Fort Dodge, Ia.; one 10-inch exhaust head and two steam separators for the Technical high school, Cleveland, Ohio, and an oil separator for the Piquay high school building, Piquay, Ohio.

New Equipment

The citizens of Ruston, Iowa, have voted to issue $50,000 bonds for improvements to the municipal electric-light plant and water works. E. S. Gray, superintendent.

Sealed proposals will be received at the U. S. Engineers' offices, Wheeling, W. Va., until 11 a.m. August 31, for building a power house at dam No. 13, Ohio river.

Plans are being considered by the Board of Revenue, of Birmingham, Ala., for the installation of an electric light and steam heating plant in the courthouse and county jail.

It is reported that a gas producer will be installed in the municipal electric light plant at Verndale, Minn., to replace the present steam plant. W. A. Lee, superintendent.

The Excelsior Springs (Mo.) and Suburban Railway Company is constructing an electric railway and will build a power plant in Excelsior. W. A. Bell, Excelsior Springs, is president.

City of Russellville, Ala., will award contract September 1 for the construction of an electric-light plant and water-works. Prof. E. B. Kay, Tuscaloosa, Ala., engineer in charge.

The Union Electric Power Company, St. Cloud, Minn., is reported incorporated with $100,000 capital to establish an electric-light plant. A. G. Whitney and others, directors.

The Colfax Springs (Iowa) Electric Railway Company has been incorporated to construct an electric railway. James P. Donahue and Dick R. Lane, of Davenport, Iowa, incorporators.

The Gary & Joliet Traction Company has been incorporated with $2,000,000 capital to connect Joliet and Gary. W. S. Reed, G. Townsend and J. W. Thomas, of Joliet, Ill. incorporators.

The United Railroad Company, San Francisco, Cal., is said to have applied for permission to rebuild its power station at Beach and Buchanan strtets. Cost, about $63,000.

Plans are being considered for improvements to the municipal electric-light plant, at Mansfield, La., which will include new generators, boilers, etc. F. M. Lawrence, manager.

The Central Wisconsin Transit Company has applied for a charter to build a railroad, to be operated by electricity or steam, from Kilbourn, Wis., to Grand Rapids, Wis. Headquarters will be at Kilbourn. Geo. H. Campbell, William Sweet and R. Wintermuts, of Kilbourn, are among the incorporators.

New Catalogs

Fort Wayne Electric Works, Fort Wayne, Ind. Bulletin No. 1107. Standard A.C. single-phase switchboard panels. Illustrated, 12 pages, 8x10½ inches. Bulltin No. 1108. Multiphase revolving-field belted generators, form A. Illustrated, 8 pages, 8x10½ inches.

Westinghouse Electric & Manufacturing Company, Pittsburg. Penn. Circular No. 1068. Types A and SA motors. Illustrated. Circular No. 1137. Integrating wattmeters for single phase and polyphase alternating current circuits and for direct current circuits. Illustrated. Booklets. Fan motors.

General Electric Company, Schenectady, N. Y. Bulletin No. 4574. Oil break switches, type F, form K-7. Illustrated, 8 pages, 8x10½ inches. Bulletin No. 4596. Enclosing globes for arc lamps. Illustrated, 4 pages, 8x10½ inches. Bulletin No. 4597. Thomson astatic instruments for continuous current switchboards. Illustrated, 12 pages, 8x10½ inches.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

WANTED—Salesman on commission for high grade power specialties. Address, stating experience, Chas. T. Luce Co., 160 Congress St., Boston, Mass.

STEAM ENGINE ERECTING ENGINEER, capable of assisting in sales department, young man with shop experience and wide acquaintance among Eastern engineers preferred. Box 33, POWER.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

POSITION as superintendent or manager. Wide and successful experience in marine, mill, pumping engines, hydraulic and steam turbines and Corliss engine manufacture, installation and operation. Box 26, POWER.

CHIEF ENGINEER of large industrial plant desires change; active and alive, an expert with indicators and testing apparatus, can keep operating expenses at proper figures. Box 27, POWER.

WANTED—Position as chief engineer or boiler room foreman in large ice and cold storage or power plant. Willing to take salary out of saving over present expense of operation. Address "Operations," care POWER.

SITUATION WANTED—By young man who has sales position but desires a wider field. Has had shop experience and technical education; ability, character and energy. Best references given. Box 30, POWER.

POSITION desired by man of eleven years of mechanical and engineering experience. Three years erecting machinery, etc., in power stations; four and one-half years as chief engineer of 5000 kw. plant. Can also operate refrigeration plants. Economy of operation guaranteed. Satisfactory references. Address "M," care POWER.

POSITION as chief engineer, machinist by trade, experienced in all kinds of steam engines, pumps, boilers and water wheels, a.c. and d.c. generators and their appliances Can furnish the best of references. Box 32, POWER.

POSITION WANTED by mechanical and electrical engineer. Work in transmission of power preferred. Practical and theoretical experience. Box 31, POWER.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ALL PRACTICAL ENGINEERS should apply to Wm. O. Webber, Consulting Engineer, 432 Exchange Bldg., Boston, for information concerning tables on all engineering subjects.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-Examiner U. S. Patent Office, 4 Dietz Bldg., Washington, D. C.

ENGINEERS—Don't miss this! For $1.50 I will send you a blueprint with full instructions how to turn off a crank pin without removing it from its place, with very little work and no cost, just as accurate as if done in a lathe. You had better take advantage of this now. Address, C. DeWitt Radliff, Merced, Cal.

For Sale

Advertisements under this head are insested for 25 cents per line. About six words make a line.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

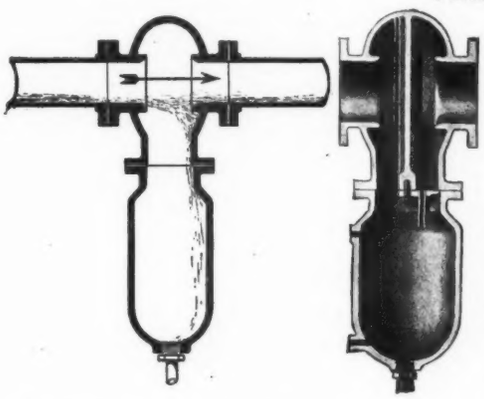
FOR SALE—500 H.P. double Corliss engine, 250 H.P. each side, 23x26, slow speed. This engine is in excellent condition and can be had at a bargain Address, Fall River Bleachery, Fall River, Mass.

FOR SALE—One 66" new American turbine, with core wheel, bridge tree pinion and 4" shafting in good condition. Cheap. Address De Pere Electric Light and Power Co., De Pere, Wis.

COCHRANE SEPARATORS

THE EMULSION STREAM

The value of Cochrane Separators depends on their performance, and their performance is assured by scientifically correct design. In the first place, means must be provided for absolutely stopping the flying particles,—those particles of moisture which are carried along in the steam,—at the same time the steam must be allowed to pass on to its work. We accomplish this by a single ribbed baffle rightly placed and proportioned,—having side ports for the passage of the steam.



Then, as the major portion of all the water or oil in an exhaust steam pipe travels along the inner surface of the pipe, or flows in a stream along the bottom of the pipe (as shown by numerous experiments and investigations), provision must be made for separating this stream by diverting it direct into a well. A mere well or "T" in the pipe will not do this satisfactorily. Some of the water or emulsion may fall into the well, but some of it will be jumped over the gap. Opportunity must be given for large flushes of water to flow directly into the well. Not only must the stream of emulsion be separated from the stream of steam, but it must be kept away from it. If the stream of steam comes into contact in any way with the water or oil or the drips from the baffle, as it will in many separators, some of the particles will be licked up into the current again. In a Cochrane Separator the drips fall from the baffle immediately into a receiver which the steam stream does not enter, and in the Cochrane Vacuum Oil Separator a ring or annular pocket is provided, extending entirely around the exhaust pipe entrance on the engine side of the separator and constantly flushed by a stream of water, for the purpose of arresting whatever oil may creep along the walls of the pipe.

Write for our 128-page Treatise on "Steam and Oil Separators."

HARRISON SAFETY BOILER WORKS,
17TH & CLEARFIELD STS., PHILADELPHIA, PA.

TALK 4

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Beggs & Co., Jas., New York.
Edge Moor Iron Co., Edge Moor, Del.
Franklin Boiler Works Co., Troy, N. Y.
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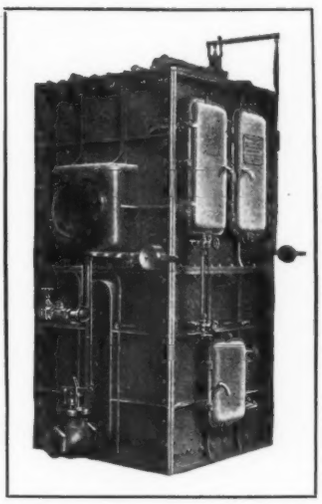

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Stewart Heater Co., Buffalo, N. Y.

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Ft. Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

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De La Vergne Machine Co., New York.
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Foos Gas Engine Co., Springfield, O.
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Struthers-Wells Co., Warren, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

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Ball Engine Co., Erie, Pa.
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Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Eng. Co., Fitchburg, Mass.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Phoenix Iron Works, Meadville, Pa.
Reeves Engine Co., Trenton, N. J.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa
Southwark Foundry & Machine Co., Philadelphia, Pa.
Watertown Engine Co., Watertown, N. Y.
Westinghouse Machine Co., Pittsburg, Pa.

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Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Engine Co., Fitchburg, Mass.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Reeves Engine Co., Trenton, N. J.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Mach. Co., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

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Triumph Electric Co., Cincinnati, O.
Westinghouse Elec. and Mfg. Co., Pittsburg, Pa.

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Phoenix Iron Works, Meadville, Pa.
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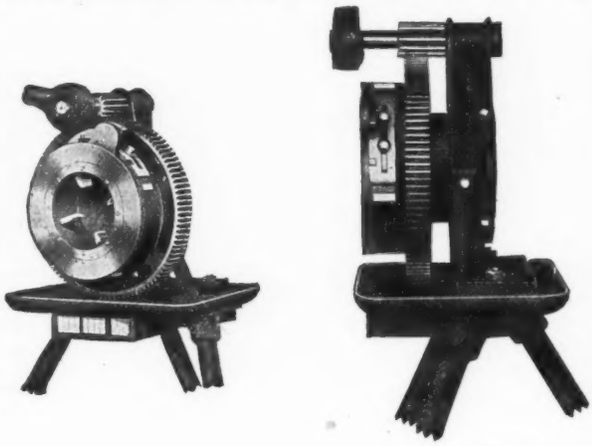

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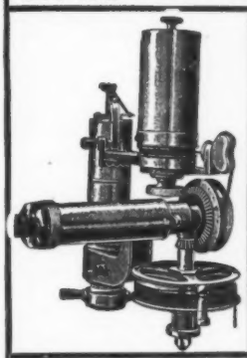

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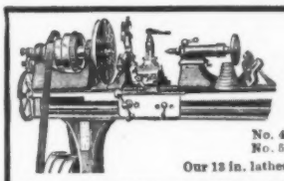

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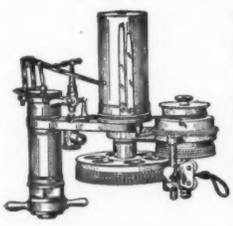

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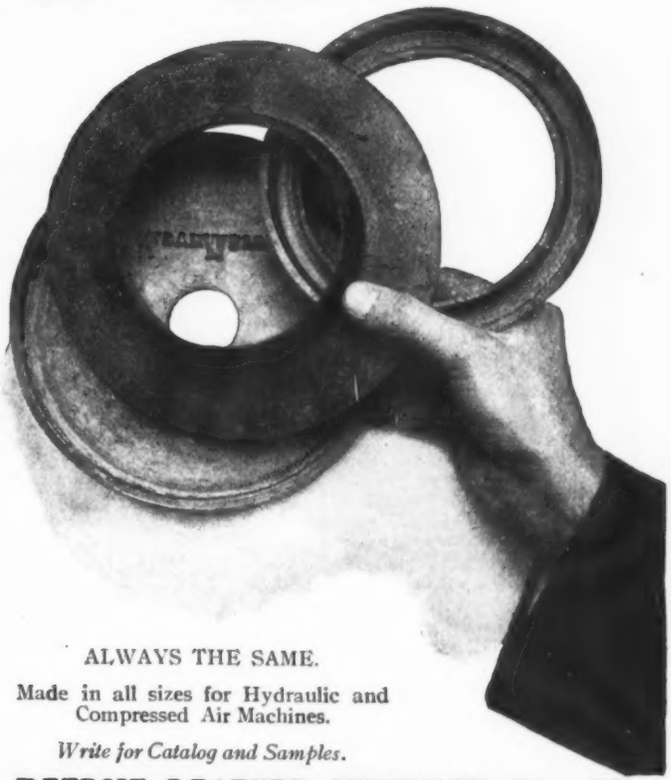

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Pittsburg Gage & Supply Co., Pittsburg, Pa.
Pittsburg Valve & Fittings Co., Barberton, O.
Pittsburgh Valve, Foundry & Construction Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

Flanges

Central Station Steam Co., Detroit, Mich.

Floats

Anderson Co., V. D., Cleveland, O.
Reliance Gauge Column Co., Cleveland, O.

Furnace Tile

C-O-Two Furnace Co., Syracuse, N. Y.

Furnaces

Continental Iron Works, Brooklyn, N. Y.
Murphy Iron Works, Detroit, Mich.

Furnaces, Smokeless

McClave-Brooks Co., Scranton, Pa.
Murphy Iron Works, Detroit, Mich.
Wilkinson Mfg. Co., Bridgeport, Penn.

Gage Glasses

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Garlock Packing Co., Palmyra, N. Y.

Gage Testing Outfit

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Gages

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
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Crosby Steam Gage & Valve Co., Boston, Mass.
Huyette Co., Paul B., Philadelphia, Pa.
Lunkenheimer Co., Cincinnati, O.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Gages, Ammonia

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Gages, Pressure

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Williams Valve Co., D. T., Cincinnati, O.

Gages, Recording

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Gages, Vacuum

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Gages, Water

Ohio Brass Co., Mansfield, O.

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American Goetze Gasket & Packing Co., New York.
Brandt, Randolph, New York.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Jenkins Bros., New York.
Johns-Manville Co., H. W., New York.
Johnson Co., Henry, Jersey City, N. J.
N. Y. Belting & Packing Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Smooth-On Mfg. Co., Jersey City, N. J.
U. S. Mineral Wool Co., New York.

Gaskets, Copper

Central Station Steam Co., Detroit, Mich.
Restein Co., Clement, Philadelphia, Pa.
U. S. Mineral Wool Co., New York.

Generating Sets

American Engine Co., Bound Brook, N. J.
Crocker-Wheeler Co., Ampere, N. J.
C. & C. Electric Co., New York.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Foos Gas Engine Co., Springfield, Ohio.
Ft. Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Skinner Engine Co., Erie, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Watertown Engine Co., Watertown, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Governors, Pump

Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Indianapolis, Ind.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Marshalltown, Iowa.
Gardner, Governor & Separator Co., Quincy, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.

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Dixon Crucible Co., Jos., Jersey City, N. J.
Garlock Packing Co., Palmyra, N. Y.

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Reagan Grate Bar Co., Philadelphia, Pa.

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Green Engineering Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Martin Grate Co., Chicago, Ill.

Grates, Clinker Cutting

Neemes Bros., Troy, N. Y.
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Grates, Shaking and Dumping

McClave-Brooks Co., Scranton, Pa.
Martin Grate Co., Chicago, Ill.
Neemes Bros., Troy, N. Y.
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Grates, Stationary

Gibson Iron Works Co. Jersey City, N. J.
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Cook's Sons, Adam, New York.
Keystone Lubricating Co., Philadelphia, Pa.

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Green Fuel Economizer Co., Matteawan, N. Y.
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Webster & Co., Warren, Camden, N. J.

Hoists, Electric

Yale & Towne Mfg. Co., New York.

Hoists, Hand

Yale & Towne Mfg. Co., New York.

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Mercer Rubber Co., Hamilton Square, N. J.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

Hose, Steam and Water

Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Mercer Rubber Co., Hamilton Square, N. J.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

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American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Gas Engine

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Hydraulic

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Speed

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Starrett Co., L. S., Athol, Mass.

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Watson-Stillman Co., New York.

Joints, Expansion

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Fort Wayne Electric Works, Ft. Wayne, Ind.
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Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

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Yale & Towne Mfg. Co., New York.

Lubricants

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Detroit Lubricator Co., Detroit, Mich.
Greene, Tweed & Co., New York.
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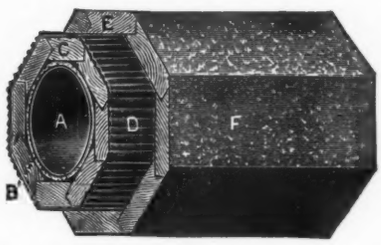

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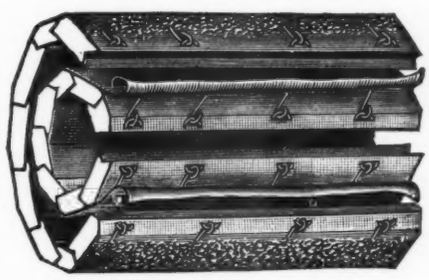

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Johnson Co., Henry, Jersey City, N. J.
Mercer Rubber Co., Hamilton Square, N. J.
Quaker City Rubber Co., Phila., Pa.
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De La Vergne Machine Co., New York.
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Westinghouse Mach. Co., Pittsburg, Pa.

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Hill Publishing Co., New York.
International Correspondence Schools, Scranton, Pa.

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Saginaw Mfg. Co., Saginaw, Mich.

Pulleys, Clutch
Williams Fdry. & Mach. Co., Akron, Ohio.

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American Steam Pump Co., Battle Creek, Mich.
Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.
Wheeler Condenser & Engineering Co., New York.

Pumps, Boiler Feed
American Steam Pump Co., Battle Creek, Mich.
Kewanee Boiler Co., Kewanee, Ill.

Pumps, Centrifugal
Wheeler Condenser & Engineering Co., New York.

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Deane Steam Pump Co., Holyoke, Mass.

Pumps, Deep Well
American Steam Pump Co., Battle Creek, Mich.
Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.

Pumps, Electric
American Steam Pump Co., Battle Creek, Mich.
Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.

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Pumps, Turbine
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Quaker City Rubber Co., Phila., Pa.
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American School of Correspondence, Chicago, Ill.
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Wheeler Condenser & Engineering Co., New York.
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Liberty Mfg. Co., Pittsburg, Pa.
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Lunkenheimer Co., Cincinnati, Ohio.
McCrea & Co., James, Chicago, Ill.
Nason Mfg. Co., New York.
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Penberthy Injector Co., Detroit, Mich.
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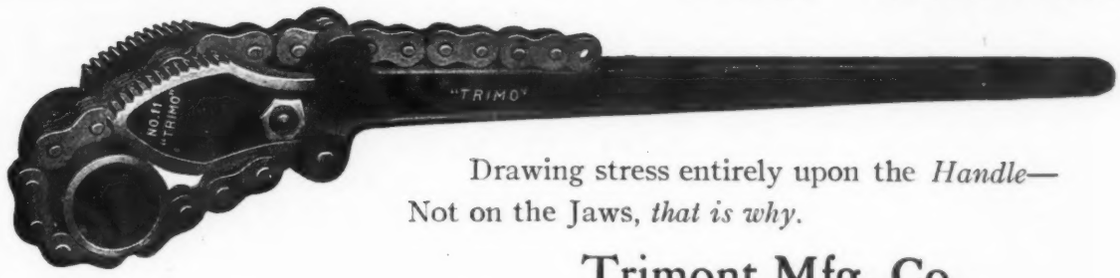

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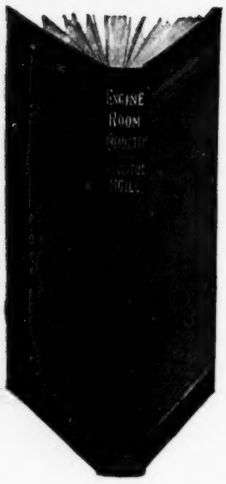

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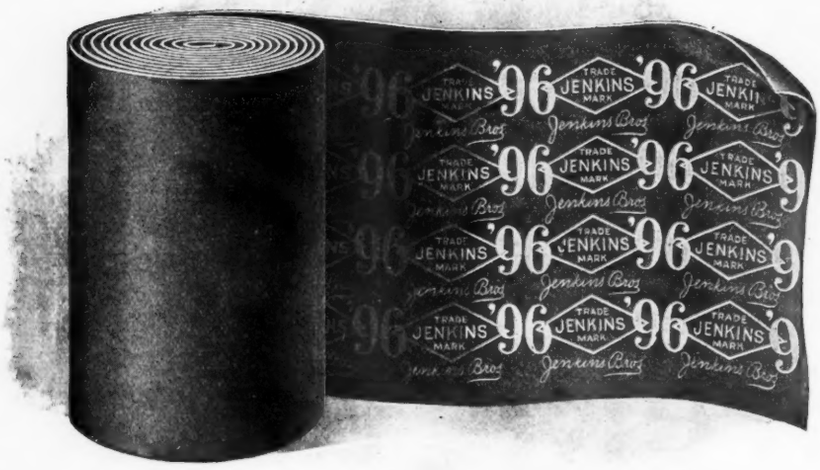

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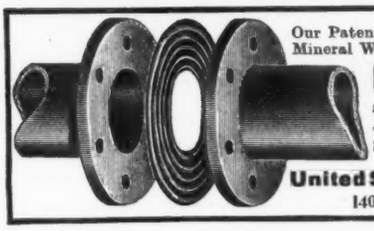


Our Patented Mineral Wool **Pipe Covering and Copper Gaskets** Save Steam and Make Absolutely Tight Joints. Best and Cheapest. Samples Free.

United States Mineral Wool Co.
140 Cedar Street, New York

HYDRAULIC JACKS

Every type of first class thoroughly guaranteed Hydraulic Jacks for all classes of work are manufactured by us.

Over 400 different types and sizes from 2 to 1000 tons capacity.

Each and every tool guaranteed.

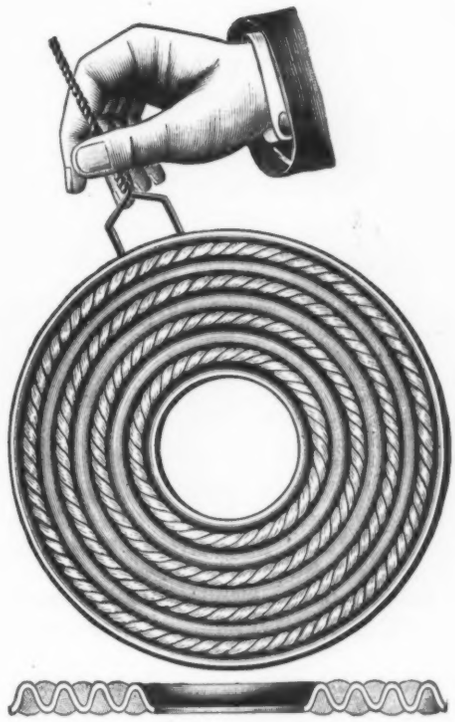
Send for Jack Catalog No. 68.

Watson Stillman Co.,

50 Church St. New York City.

Chicago Office, 453 Rookery.

Free Sample On Request



Pick out the most troublesome flange or other joint in your plant, send us the size and description and we will send a Goetze's Copper Gasket that will make it the least troublesome of all your connections.

WRITE.

American Goetze-Gasket and Packing Co.
525 East 149th Street,
New York City.

In Summer's heat, this maiden neat
goes to the shore for rest
But even here, she sees quite clear
riding the ocean crest
The same glad sight, that makes things right
No matter what the test
It goes to show, what all should know,
BLACK SQUADRON is the best.

BLACK SQUADRON

is the one packing that never fails. Others may do fairly well for some kinds of service, but why take chances—*be sure* and *make sure*, by using the original sliding wedge Black Squadron Packing. High and Low pressure varieties for Steam, Water, Air, and Ammonia. Illustrated Catalog on request.

CANCOS MFG. CO.,
Philadelphia, Pa.

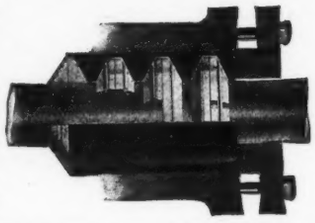
10 Oliver St., Boston, Mass. 525 Third Ave., Pittsburg, Pa.
805 Plowman St., Baltimore, Md.

You won't be satisfied 'till you get Selden

because it is the one tough, pliable, elastic packing that will keep rods tight, even when they are scored and worn. If you think it won't pay for itself you need not pay for it. Write.

RANDOLPH BRANDT, 72 Cortlandt St., N. Y.

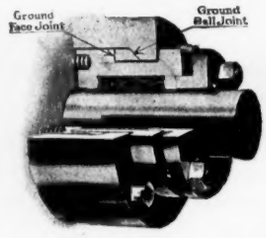
No More Soft Packing Bills



provided you use Sterling Metallic Packing for your Steam, Air, Oil and Ammonia Rods. The leading engine builders and engineers the world over endorse it. 'Tis different, better and more durable than any other metallic packing on the market. Made to suit any stuffing box without alteration and lasts as long as the engine. Write today for catalog and *what users say*.

Monarch Steam Blower Company
Troy, N. Y.

VIBRATING STUFFING BOX



"It Floats with the Rod"

"SAFETY"

PLASTIC

Metallic Packing

FOR STEAM, WATER, AIR, GAS, HYDRAULIC MACHINES, VALVES, ETC.

Guaranteed to stand Steam Temperature up to 550 degrees F. and Hydraulic Pressure to 5,000 lbs. per square inch.

HIGHEST AWARD WORLD'S FAIR, ST. LOUIS.

Send for Free Sample and Particulars

Manufactured Solely by STEEL MILL PACKING COMPANY, Detroit, Mich., U. S. A.

"SAYEN-REED"

SAYEN-REED ASBESTOS PACKING

Specially Adapted for High Pressure and Super-heated Steam—The fabric is woven from strands made of brass wire and asbestos. Rubber is then forced in the interstices and vulcanized. The result is a remarkably strong, flexible and durable packing which no pressure will blow out.

Write for Free Sample

This packing is better than others—far better—and, better still, is lower priced. We will gladly send samples FREE upon request.

MERCER RUBBER COMPANY

HAMILTON SQUARE **NEW JERSEY**

BRANCH OFFICES—Philadelphia, 421 Arcade Building; New York, 250 Fulton Street; Pittsburg, 8th and Liberty Streets; Denver, 640 Exchange Building; and Chicago, 40 Dearborn Street.

BELMONT

HIGH PRESSURE STEAM PACKING.

See the wedges ?

Each one is woven from the finest long stock asbestos from which all metallic particles have been removed by the magnetic process.

The back to which these are cemented is composed of a special rubber compound which will not become brittle or disintegrate under **highest steam pressures.** The entire packing is lubricated with the very highest grade of graphite, in connection with our special high test lubricating compound, so that **BELMONT HIGH PRESSURE WEDGE PACKING** is absolutely non-friction in character throughout—cannot carbonize or dry out under any steam pressure or temperature, and will give better, safer and longer service than any other packing ever made.

It is an especially excellent packing for **high speeds** and **high pressures** on **steam, gas** or **marine** engines; and when exposed to **superheated steam.** *Illustrated catalog mailed on request.*

FREE!

SEND FOR A SAMPLE RING AND BE CONVINCED.

CLEMENT RESTEIN CO.,
Philadelphia, Pa.

Gentlemen :—

Send me a sample ring of BELMONT HIGH PRESSURE WEDGE PACKING, Style No. 50.

Name.....

Address.....

Firm Name.....

Number of Engines.....

Number of Pumps.....

Number of Boilers.....

High or Low Pressure.....

Packing now in use.....

Power, 8-25-08.

CLEMENT RESTEIN CO.,
133 North Second St., PHILADELPHIA, PA.

Possibilities of Salary Raising

F. L. RAY

THE possibilities of your securing a raise in salary depend 90% on one thing—upon your securing the knowledge and **training** that will really qualify you to hold a higher position commanding a larger salary. Such training has helped thousands of men in the same way that it helped Frederick L. Ray to advance from work as a machinery erector to power superintendent for the Stanley Rule & Level Company, of New Britain, Conn., and later to superintendent of construction for W. M. Sheehan & Co., New York City. Mr. Ray's earnings have, of course, increased very largely since he became an I. C. S. Trained man—for it was through the I. C. S. that he secured his training. It is **training** that counts. You **must** bring training into your work today if you wish to secure anything above a subordinate position with low wages.

The quickest, surest, and most practical way in the world to secure this training is by the plan of the International Correspondence Schools, an institution backed by a capital of six million dollars and with nearly 17 years' experience in the sole business of providing ambitious men with salary-raising training. You do not have to leave home or your present work. Full details of how this plan can be adapted to **your personal needs and circumstances,** no matter how scant your time, money, or education, will be sent free to any one marking and mailing the coupon below. This puts you under no obligation. If you really want a better position use this coupon **now.**

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 979, Scranton, Pa.

Please explain without further obligation on my part, how I can qualify for a higher salary and advancement to the position before which I have marked X.

Electrical Engineer	Machine Designer	Sanitary Engineer
Elec.-Lighting Supt.	Mechanical Draft.	Architect
Elec.-Railway Supt.	Foreman Machinist	Architectural Draft.
Electrician	Foreman Toolmaker	Ad Writer
Telephone Engineer	Foreman Molder	Window Dresser
Civil Engineer	Foreman Blacksmith	Chemist
Bridge Engineer	Marine Engineer	Sheet-Metal Draft.
Mechanical Engineer	Hydraulic Engineer	Ornamental Design.
Stationary Engineer	Municipal Engineer	Textile Designer
Gas Engineer	R. R. Construc. Eng.	Bookkeeping
Refrigeration Eng.	Surveyor	Stenographer
Traction Engineer	Mining Engineer	Civil Service Exams.

Name _____

St. and No. _____

City _____ *State* _____

DAVIS
PRESSURE
REGULATORS
SAVE
STEAM

PRESSURE
REGULATOR

Do It Automatically

If you are using live steam for heating, drying, cooking or some other purpose at a pressure lower than that carried on the boiler, let the Davis Pressure Regulator make the reduction for you automatically.

This valve can be adjusted to deliver steam at just the pressure needed and it will maintain that pressure without fluctuations no matter how much the initial boiler pressure may vary.

Reducing steam by throttling through a cracked globe or gate valve is about as satisfactory as using saw dust for fuel. You may be able to get along after a fashion, but why not do it right—automatically.

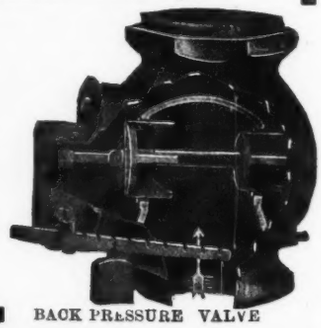
If you are running your engine non-condensing a Davis Automatic Back Pressure Valve will enable you to make use of the exhaust steam instead of letting it go to waste.

Contrast this valve with its semi balanced disc, small weight and noiseless operation without any possibility of injury to the seats, with the old style single seated valve which pounds like a trip hammer and keeps you poor buying seats for it. Is there any comparison—would you choose the single seat ?

Send for a complete catalog of Davis Valve Specialties. It is of interest to both owner and operator.

G. M. Davis Regulator Company,
142 Milwaukee Ave., CHICAGO.

BRANCHES—NEW YORK—123 Liberty St. BOSTON—104 High St. ST. LOUIS, 735 S. 4th S.
SAN FRANCISCO—216 California St PHILADELPHIA—56 N. 2nd St.
PITTSBURGH—1206 Park Building.



BACK PRESSURE VALVE

VALVES

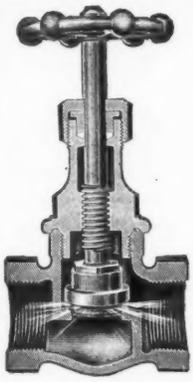
Makes no difference what kind of a Valve you want, how you want it made or where you want it shipped, we can supply it on shortest possible notice.

We manufacture valves and pipage equipment of every description, for all kinds of plants, Steam Separators, Tuyere Cocks, Brass Unions, Etc. Also make Pipe Bends, and do all kinds of Pipe Fitting, either assembled or ERECTED.

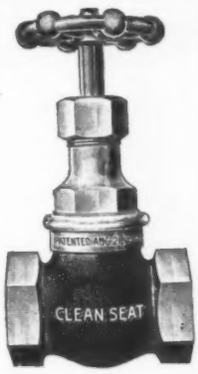
SEND FOR CATALOG

PITTSBURGH VALVE FOUNDRY & CONSTRUCTION CO.

Pittsburgh Cleveland New York Boston Birmingham, Ala.



CLEAN-SEAT VALVES



ARE BEST WE SAY SO, AND CAN PROVE IT:

1. A VALVE tightly closed does not wear fast.
2. A VALVE cannot close tight on a dirty seat.
3. A VALVE should be able to keep its seat clean.
4. A VALVE which can do this will wear well.

THE CLEAN SEAT VALVE, every time it closes, throws a strong jet of steam directly across the seat, all the way round, as the disc approaches the seat. This jet blows away all sediment, scale, grit, rust, or other foreign matter, and insures tight closing *every time*, by clean metallic contact between disc and seat.

The "Clean-Seat" principle reduces the wear on seats and discs to a positive minimum and makes easy the ordinarily difficult work of controlling high pressures. For high pressure service this valve makes its most conspicuous showing, and it is made in the following heavy weights:

Medium for pressures up to and including 200 lbs.
Extra heavy for pressures up to and including 500 lbs.
Hydraulic for pressures up to and including 3,000 lbs.

For long, hard and continuous service the "Clean-Seat" Valve has no rival. On this claim, we stand ready to submit conclusive proof, beyond even a reasonable doubt.

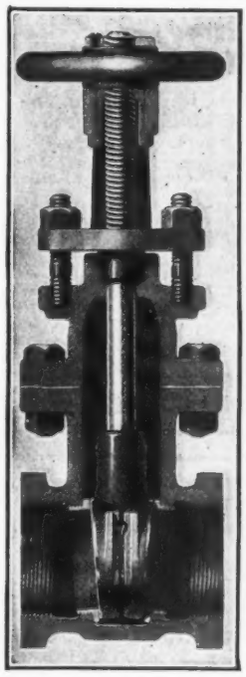
PRICES:

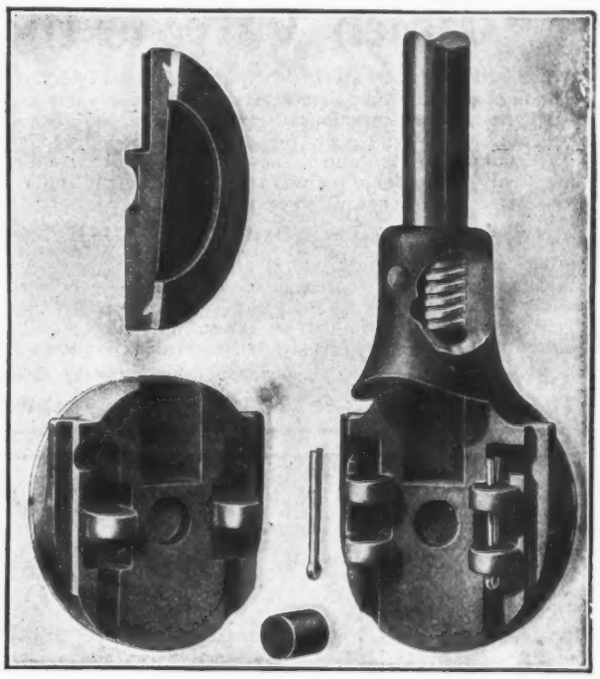
Size.....inches	⅛	¼	⅜	½	¾	1	1¼	1½	2	2½	3
Medium.....each	1.10	1.10	1.25	1.60	2.20	2.80	4.00	5.50	8.75	15.75	22.00
Extra Heavy. "	.....	3.00	3.50	4.00	5.00	6.50	8.25	11.00	16.00	33.00	45.00
Hydraulic... "	.....	5.00	5.00	6.00	7.50	10.00	12.50	16.50	24.00	50.00	65.00

PITTSBURGH GAGE & SUPPLY CO., Pittsburg, Pa.

IF YOU ARE INTERESTED IN POWER PLANT EQUIPMENT YOU WILL BE INTERESTED IN THE

PITTSBURGH IRON-BODY GATE VALVE





for the following reasons:

1 This valve combines the features of both the solid wedge and loose disc valves and does not have the disadvantages of either. This is done by making one of the discs a solid wedge and hinging the other to it as shown in sketch so as to allow both to adjust themselves to the seats.

2 This valve has less wear on the faces of the discs and seats than any other valve made. This is secured by having the discs guided by ribs cast in the body of the valve thus allowing them to lift away from the seat without scraping and abrading.

3 This valve will not leak due to expansion strains from piping because the bosses are drilled and pinned together with cotter pins so loosely that they can move in either direction upon the plug and adapt themselves to the seats whatever the conditions may be as to parallelism.

4 The discs of this valve are faced with steam metal which is forced into an undercut groove in the face of the disc by a special machine using rolling pressure, which both compacts and surfaces the metal.

5 Quality is never sacrificed to secure cheap production. This valve is made of the highest grade material and is finished by skilled mechanics with the latest and most approved machinery that money can buy.

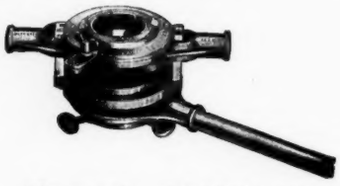
6 Thousands of these valves are in use in all parts of the country and we have never had a complaint.

PITTSBURGH VALVE & FITTINGS CO., General Offices and Works, BARBERTON, O.

Pittsburgh Gate Valves are made Standard for 150 lbs. and Extra Heavy for 250 lbs. working pressures. They can be furnished Flanged, Screwed or Hub End, with Non-Rising Spindles or Outside Screw and Yoke. Write for Catalogue.

"BEAVERS" are the proper die stocks for use about factories

BECAUSE they are built on the easy working principle, enabling one man to thread any size pipe without calling for help.
Each Stock threads all sizes of pipe within its range without changing dies so you have no loose parts to carry around or get lost or misplaced.
And consider the time you save by not having to change dies.
They are a time proven success and of such practical advantage in saving time and labor as to compel their use from an economical standpoint once you realize it.



"Beaver" 1" to 2" Ratchet Stock.

Made in all sizes ¼" up.
Sold by all Jobbers subject to 10 days' trial.
We would like to send you descriptive matter.

THE BORDEN COMPANY
WARREN, O.

Absolutely Protected From Wear

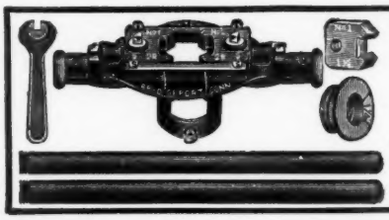
The plug of a Homestead Valve is held firmly in place by a traveling cam. BOOKLET?

Homestead Valve Mfg. Co.,
Brass Founders. Pittsburg, Pa.

Buy By Our Trade Mark

and you will be sure of simple, self contained, easily and accurately adjusted reducing valves. *Catalog?*

The Mason Regulator Co.,
Boston, Mass.

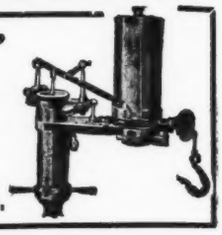


STOCKS AND DIES
PIPE MACHINES,
PIPE CUTTERS,
VISES.
Manufactured by
The Armstrong Mfg. Co.
287 Knowlton St.,
BRIDGEPORT, CONN.

Not A "Just-As-Good" But Just A Better

indicator than any that costs even $50 more and we are ready to prove this claim to anyone who is interested.

Trill Indicator Co., Eagle St., Corry, Pa.



"Which Valve is the Best?"

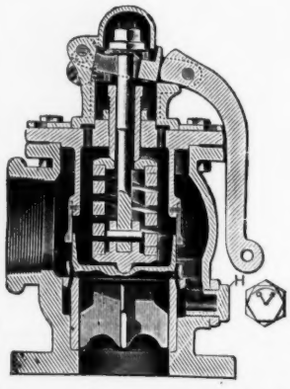
When ordering new valves, this question naturally comes to mind before any other. The next question that suggests itself is "Which valve costs the least to maintain?" To both of these questions there can be but one answer—*Williams Valves* are *best* because they stand higher pressures and last longer than others. *Cost of maintenance* amounts to nothing as they do not require extra discs or seats. If worn, they are easily and quickly reground with a little oil and emery. When finished, the valve is as good as new at no extra cost.

WILLIAMS SWING CHECK VALVES

are excellent valves for use on boiler feed lines or any other place where the pressure must be controlled by a check valve. Heavy in construction, they have full and unobstructed passage through body which greatly reduces friction and necessarily prolongs the life of the valve. If you want higher valve efficiency at less cost—order Williams. They are strictly guaranteed for 200 pounds pressure.

Send us a postal for the new Williams catalog.

THE D. T. WILLIAMS VALVE CO., 904-910 BROADWAY, CINCINNATI, OHIO.



YOU WILL NOT

and no one else can change the adjustment of this Ashton Valve after you have set it as it should be. Made of the best materials by men who know the value of such materials and get the best results from them.

Catalog on Request.

THE ASHTON VALVE COMPANY.

BOSTON. NEW YORK. CHICAGO.
St. Johns House, London, E. C.

ARE YOU SATISFIED

With having your valves sputtering, sissing and wasting steam, as leaky valves do, when they can be made perfectly tight with a

Dexter Valve Reseating Machine?

As these machines soon pay for themselves, don't you believe it would be good judgment to have a machine that will save you all this annoyance and waste?

You can find out all about them by using a machine all you care to for 30 days and then return it at our expense if you do not want it.

Send for Catalog "P" Illustrating these Machines.

The LEAVITT MACHINE CO.
Orange, Mass., U. S. A.

"Ohio" Steam Specialties

OHIO WATER GAUGE

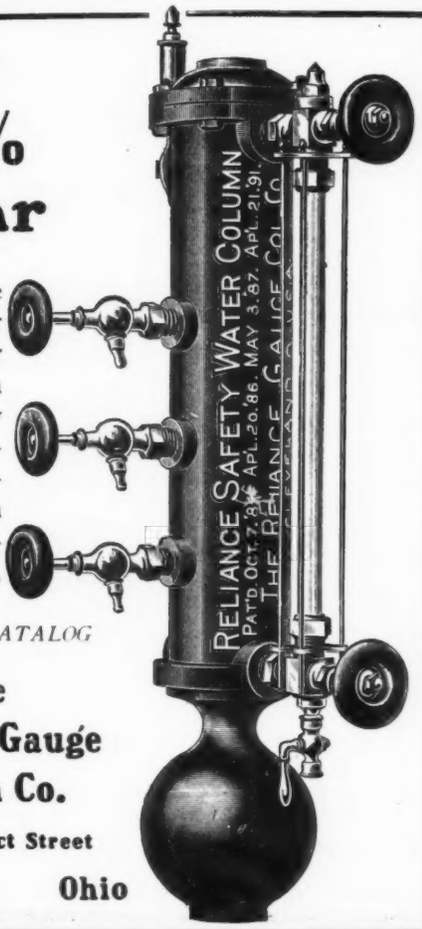
The "Ohio" water gauge is of the highest grade, finely finished and of the latest approved quick operating design. The gauge glass can be removed through an opening in top fitting. Guaranteed for 200 lbs. pressure.

We also make a line of high-grade bronze Collin Gauge Cocks, Heavy Bronze Fittings and Collin Steam Pressure Regulating Valves.

Catalogs P-F and P-B mailed on request.

The Ohio Brass Company
Mansfield, Ohio, U. S. A.
32 Cortlandt Street, New York
277 Dearborn Street, Chicago
138 Front Street, San Francisco

Over 100 % a Year



The Reliance Safety Water Column pays for itself in less than a year to say nothing of preventing accidents which might cost thousands of dollars.

ASK FOR CATALOG

The Reliance Gauge Column Co.
75 E. Prospect Street
Cleveland, Ohio

A Leakless Self-Closing Gauge Cock

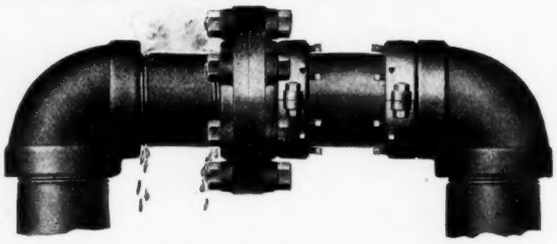
The "P.B.H"

Sent On 30 Days' Free Trial

The valve pencil is the only part that needs renewing (and it won't need *that* for a long time). When it does become worn, it is easily removed and replaced for a few cents.

Try it on your boiler for 30 days. If it doesn't prevent dirt and drizzle we'll refund your money.

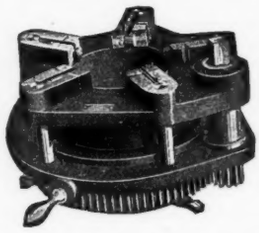
THE PAUL B. HUYETTE COMPANY,
2025 BETZ BUILDING, PHILADELPHIA.



The Simplex Pipe Clamp

absolutely guaranteed to make the worst leaky joint permanently tight—sent on 30 days' free trial.

THE SIMPLEX ENGINEERING CO.,
316 Preston Street, PHILADELPHIA, PA.



EMERGENCY WORK IN POWER PLANTS MUST BE DONE IN A HURRY.

"TOLEDO" Pipe Threading Devices

thread pipe up to 12". ONE MAN can do it quickly and *in any place, in any position.* An invaluable line of tools. Let us tell you about them.

The Toledo Pipe Threading Machine Co.,
TOLEDO, OHIO.

DEBUT

It is needless to say that steel pipe requires a sharp, properly shaped die to produce good threads. The little machine shown here is the

B. & K. DIE GRINDER

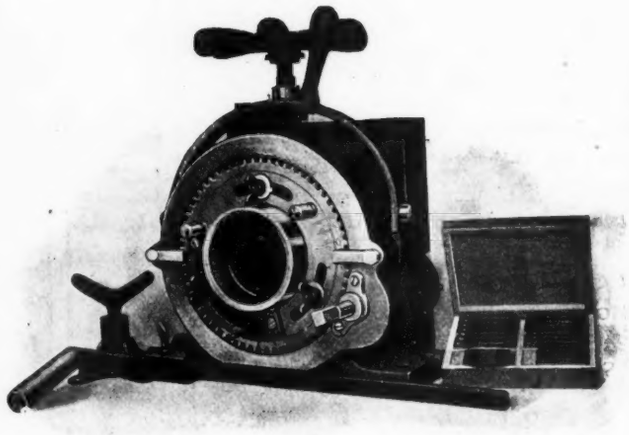
for the correct grinding of the dies. Simple to operate, modern in price, and will save you dollars. Shall we send description ?

BIGNALL & KEELER MFG. CO.
EDWARDSVILLE, ILL.

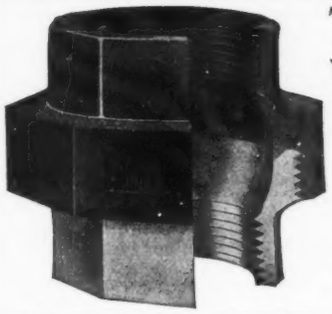
The Shell Is Adjustable To Take Up The Wear

Other features of this Pipe Cutting and Threading Machine are: Reasonable first cost, great saving of time and labor, dies which can be replaced one at a time, perfectly interchangeable parts, adaptability to work in confined quarters, a great reduction in weight over the old die stock and vise, etc.

Catalog ?



The Curtis & Curtis Company
85 Garden St., Bridgeport, Conn.



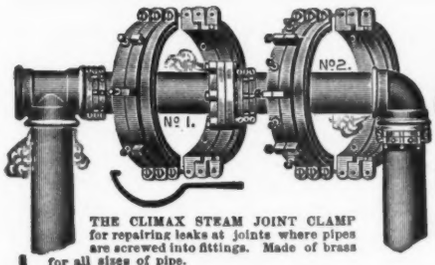
Tested Under Water By Air

That's how we test "KEWANEE" UNIONS. We wouldn't sell you a "Kewanee" at any price if it leaked. Save time, material, labor and money by using them. You'll need no gaskets. Details for the asking.

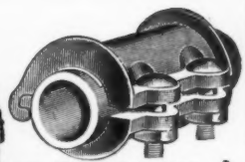
NATIONAL TUBE CO., Pittsburg, Pa.

DISTRICT SALES OFFICES:

New York	Chicago	St. Louis	Pittsburg
Philadelphia	Denver	Atlanta	New Orleans
San Francisco	Portland	Salt Lake City	Seattle



THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.



THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ½ in. to 12 inches.

PIPE REPAIRS FOR ANY CONDITION

Send for Catalog of

STEAM SPECIALTIES

JAMES McCREA & CO.,

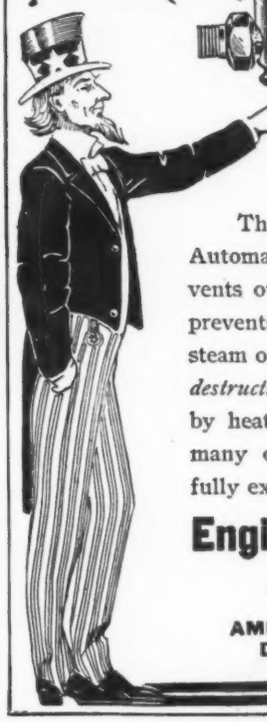
MANUFACTURERS,

61 West Washington Street, Chicago.

No Freezing Here

The Drip Cock prevents it

U.S. Automatic Injector



The Drip Cock of the U. S. Automatic prevents freezing; prevents overheating of suction pipe; prevents jet "liming up" when steam or check valve leaks; *prevents destruction of hose on traction engines* by heat from hot water, and has many other exclusive advantages fully explained in our

Engineer's Red Book

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Chicago Automatic Injectors

Prove their Quality in Actual Operation

No boiler feeding troubles when you have a powerful Injector that is built for service.

The Chicago Guarantees a Full Boiler when you want it

It is positive in its work and has nothing to get out of order. Built unusually strong.

THE BEST PROTECTION FOR BOTH BOILER AND ENGINEER

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THE CHICAGO EJECTOR, a powerful little instrument for elevating, forcing and conveying liquids. Does marvelous work with but little steam.

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Regulation size, stem wind and stem set, with heavily nickeled case. Guaranteed for one year if used with reasonable care. Keeps splendid time. The reputation of one of the largest watch makers in the country stands behind it.

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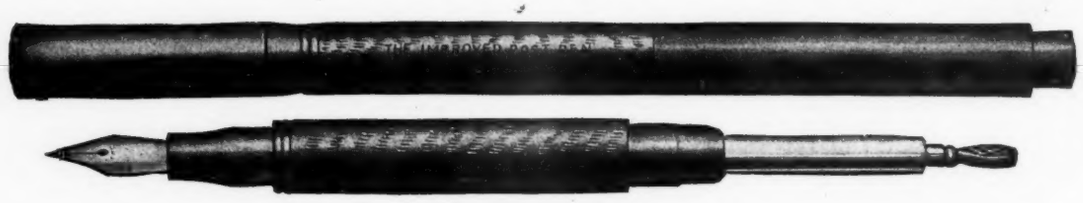

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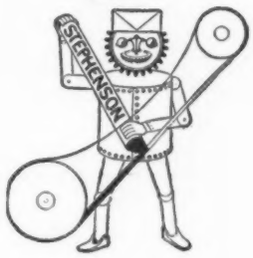

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Send us 2c. for testing Sample, and say which:

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No one kind is good for all belts—
you know that.

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OXoilOX

nature's belt food, made from the hoofs of cattle. It drives out this old gummy stuff; leaves the belts soft, tough, and clean. Then they **have** life and health. They cling so closely to pulleys that all air is excluded and the vacuum thus formed enables a belt to run slack at its full capacity without slipping. Start **new** and **right** with **OXoilOX.**

FREE

F. S. WALTON CO., Philadelphia, Pa. Gentlemen: Kindly send us, free of all charge, a sample can of OXoilOX, the perfect belt dressing.

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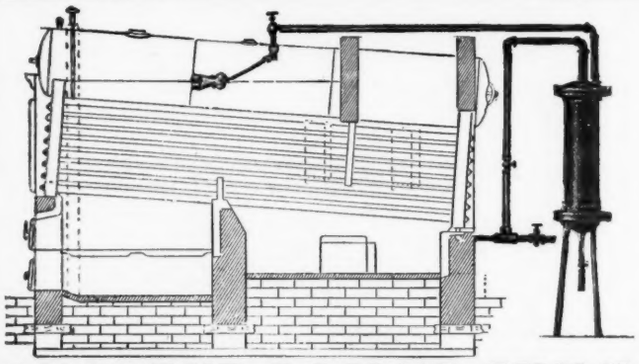
NUMBER OF BELTS ..... AVERAGE SIZE .....

F. S. WALTON CO. **Pressers and Refiners of all grades of Neatsfoot Oil,** **PHILADELPHIA, PA.**



Just One Cost And That A Low One.

Boiler compounds and mechanical scale removers cost over and over every time they are used yet they fail at all times to effect as good a result as the Buckeye Boiler Skimmer. Just figure the value of permanent freedom from scale then write for our Catalog.

BUCKEYE BOILER SKIMMER CO., South End, Toledo, O.

Protect Your Plant From Fire And Your Men From Injury

by preventing bursted boiler tubes. More tubes rupture from overheating than from any other cause. Overheating results from an insulating layer of scale or greasy deposit within the tube.

BIRD-ARCHER BOILER COMPOUNDS

prevent the formation of this scale and greasy deposit, and by so doing, not only reduce danger and repair bills, but permit the boiler to deliver the greatest possible amount of steam without waste of coal.

Guaranteed on a "NO CURE, NO PAY" basis.

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SAVE POWER BELTING BEARINGS

If you want belts that can run slack and yet develop the most power in severe service, or in changing temperature and humidity.

If you want belts that will last nearly a life-time without sign of weakness,

SHULTZ SABLE RAWHIDE BELTING

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Get a SHULTZ SABLE RAWHIDE BELT for 60 days free trial.

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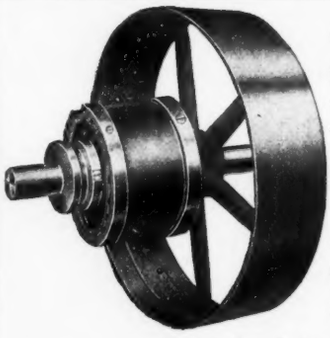

All Operating Parts run in an oil bath thus making the

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exceedingly durable and the most easily operated friction clutch ever devised.

Ask for full particulars.

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Eliminates The Glue Pot

SOLVES THE BELT PROBLEM.

The Scientific Principle:

Continuous strands are spirally cut from the choicest leather locations of the belting butt to exact mechanical gauge. The strands are then separately stretched to the extreme elastic limit and assembled on edge forming a belt of any practical length, width or thickness. Made endless on pulleys with a simple interlocking splice.

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A continuous belt without laps, plies or cement. Absolute uniformity of strength, gauge, balance and flexibility. Complete adjustment to varying pulley conditions with the maximum of surface and circumferential contact. Remarkable power transmission and highest productive efficiency.

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WARRANTY

We absolutely warrant **Magic Boiler Compound:**

1. To remove scale already formed in boilers, in any locality, in any water.
2. To prevent more scale forming.
3. To remove oil and grease.
4. To stop minor leaks in a boiler.
5. To stop pitting and galvanic action.
6. Not to injure the metal in boilers.
7. Not to evaporate from the boilers.
7. Not to affect the packing, lubricants, or product of your plant which may come in contact with the steam.
9. Not to cause your boiler to foam.
10. Not to injure any valves.

It MUST Remove Old Scale and Prevent More From Forming Before You Pay Us One Cent

WE will send you enough MAGIC BOILER COMPOUND for a 60 days' trial in your plant, with the distinct understanding that if it does not do all we claim in the above warranty, when used according to directions furnished, it won't cost you one cent.

MAGIC BOILER COMPOUND is different from any other compound ever placed on the market. Its action is *not chemical* but mechanical and natural. Iron under heat attracts it like a magnet attracts steel. It is drawn through the cracks in the scale and works its way between the scale and the iron, loosening and causing same to drop off. The scale sediment can then be blown off or washed out.

MAGIC BOILER COMPOUND

then forms a coating on the iron to which no further scale can adhere.

NOW, don't think that because other boiler compounds you have used were no good that they are all the same. You have probably smoked some poor cigars, but that doesn't make you think that all cigars are bad. If a packing kept blowing out continually, you wouldn't hesitate to try another kind, would you? Then why continue to be troubled with boiler scale, when it must be plain to you that MAGIC BOILER COMPOUND will permanently put an end to boiler scale troubles, or we would not offer to go to the expense of sending you a trial order and make no charge therefor, if it failed. Even if we didn't care about the expense, could we afford to injure the reputation we have built up during the past half century by making false claims?

Please fill in the coupon attached and mail it to us today

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Manufacturers of Asbestos and Magnesia Products, Asbestos Roofings, Packings, Electrical Supplies, Etc.

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Date .....

H. W. JOHNS-MANVILLE CO.

You may ship us via ..... *enough* **Magic Boiler Compound** *for 60 days' trial in our plant. If we find that it does not do as claimed, you are to make no charge therefor, otherwise we will pay for the material at 10c per pound.*

We have ..... *boilers. H.P. each* .....

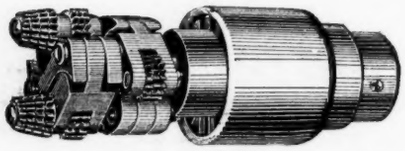
Operate ..... *hrs. per day. Condition of boilers now* .....

Name .....

Address .....

City .....

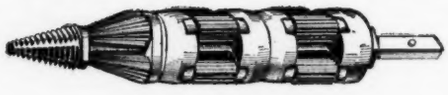
This Weinland Wing Head Turbine



is the best turbine ever made for removing any scale that shows up. The heavy wing arms fly out and crush the scale in no time, and will work better, with less water, in shorter time, and with smaller repair bills than any other turbine that was ever put into a boiler. Made with ball bearings for light, and thrust bearings for heavy duty. The Wing Head is furnished with all new Weinland Turbines and can be used on all Weinland Turbines.

For severe scale an inch thick or Tubes "chuck full"

This Weinland Mechanical Cleaner



is the only one that will do the work speedily and economically. Can be driven by steam, electric, water or air motor, any desired power. We'll sell or rent this Cleaner or clean your boiler by contract. You can learn A LOT during the operation and afterward, by using our Turbine with reasonable frequency, can keep your boilers in finest condition. If you have a large plant where cleaning goes on most all the time, think you had better own this machine.

Tell us your scale troubles. We will tell you the remedy, and let you try a Weinland Cleaner free to prove our statements. If it isn't what you want, you can send it back.

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MAKERS OF LAGONDA AUTOMATIC CUT-OFF VALVES, RESEATING MACHINES AND TUBE CUTTERS.

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In Yale & Towne Chain Blocks

are embodied the final development in lifting mechanism and the highest integrity in Chain Block construction. They lead in efficiency, speed, durability, reliability and universal adaptation to every hoisting requirement.

Triplex Blocks—⅛ to 40 tons. Universally recognized as the most durable and efficient Chain Block made. Have balanced train of spur Gearing with large internal gear.

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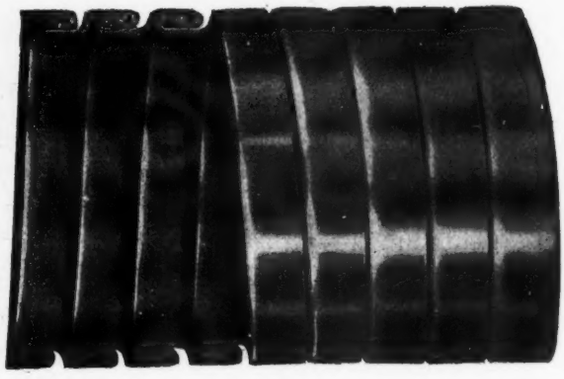

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is made of copper or galvanized steel tape rolled into spiral form in one continuous length. The interlocking edges enclose an asbestos thread packing.

Made in all sizes from ⅛" to 12", used for high pressures and all liquids, compressed air, steam, gases, oils, etc. *Write.*

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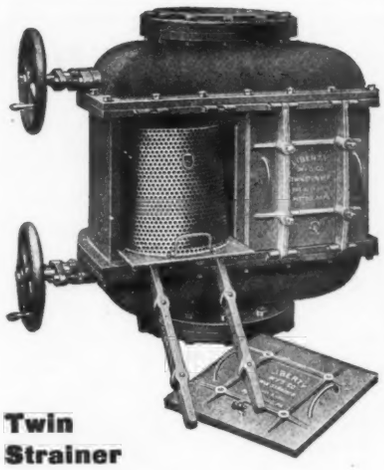
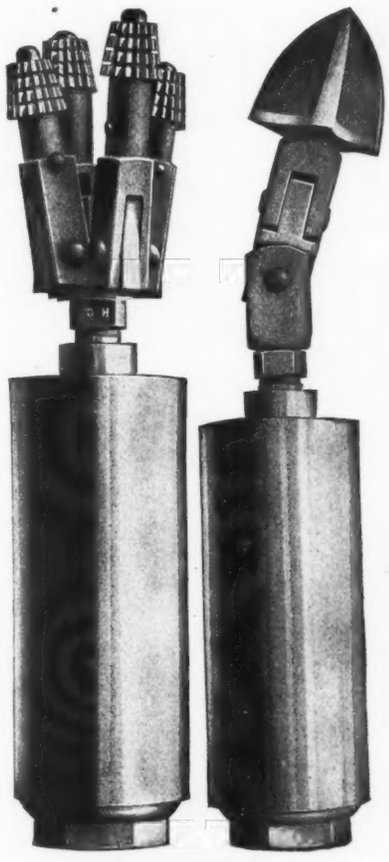
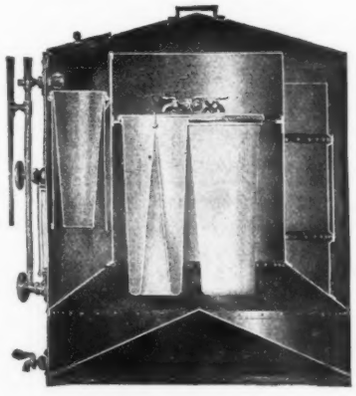


Twin Strainer



Turbine Cleaners



Oil Purifier

A pipe may clog up in half a minute so that it will take half a day or more to clear it. **The Liberty Twin Strainer** never relaxes its operation even for a second—one side is always working while the other side is being cleaned.

One thirty-second of an inch of scale cuts down your steaming capacity 15% or increases your fuel cost by that much. **The Liberty Turbine Cleaners** will remove every particle of scale from your tubes and its remarkable speed makes possible the cleaning of three tubes while another cleaner would be cleaning one.

No waste, no water, no charcoal or bone dust.

The Liberty Oil Purifier is not a filter or washer but an oil refinery on a small scale. 90% of its work is done in the settling chamber.

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AUTOMATIC LUBRICATORS

give perfect force feed lubrication and *save oil, time, money* and *labor.*
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We Challenge You

to find a bearing in your entire plant which Mica Flake Lubricant will not keep cool—or a hot bearing which Mica Flake Lubricant will not cool while running! Our challenge is contained in a small envelope sample, freely offered for demonstration purposes, of

Mica Flake Lubricant

Do you accept our challenge? Send for the test sample! Mica Flake Lubricant is radically different, in principle and performance, from Graphite or any other lubricating material.

Keeps the metal bearing surfaces actually apart—reduces friction—cools hot journals—lengthens the life of your oil—saves costly delays and break-downs—increases operative efficiency!

Mica Flake Lubricant is pure Mica—pure white—will not discolor or damage fabrics. Write for literature, prices, and the test sample!

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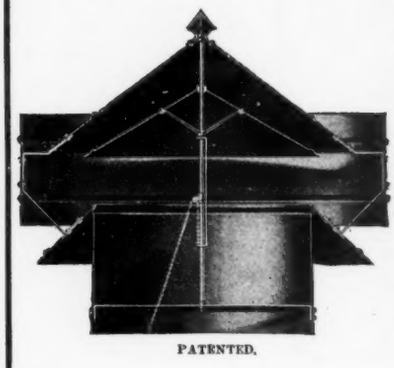
"SWARTWOUT"

GRAVITY-CLOSING

VENTILATOR



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combines the best ideas, the best material and the best workmanship that can be put into a ventilator. It is built for long life, for easy operation and efficient service.

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Also manufacturers of "Swartwout" Cast-Iron Exhaust Heads, Steam and Oil Separators.

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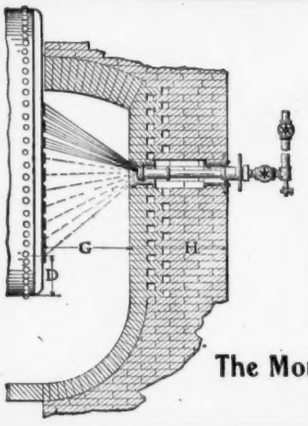
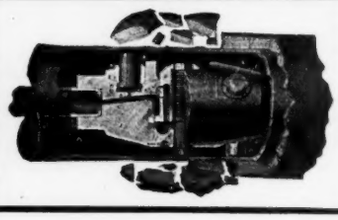


THE THIEF

in your boiler room is soot. It's robbing your fuel pile all the time and you're an accessory before the fact if you don't take measures to prevent the accumulation of soot in your boilers. The Monarch Flue Blower will clean 'em and keep 'em clean. Blows with the draft, uses dry steam, works from the rear of the boiler. *Circular or Order Blank?*

The Monarch Steam Blower Co.
Troy, New York

THE "TORPEDO"
Removes all scale from tubes of fire tube boilers.
Saves 11 per cent. of fuel for each 1-16 inch of scale.
Prolongs life of tubes.
Saves compound.
Centers itself in tube.
Strikes same in every direction.
Stroke limited and cushioned.
Does not hammer but vibrates the tube.
Is absolutely safe and easily operated.
Has but one moving part.
Will last a lifetime.



The "Torpedo"

THE IDEAL CLEANER FOR FIRE TUBE BOILERS.

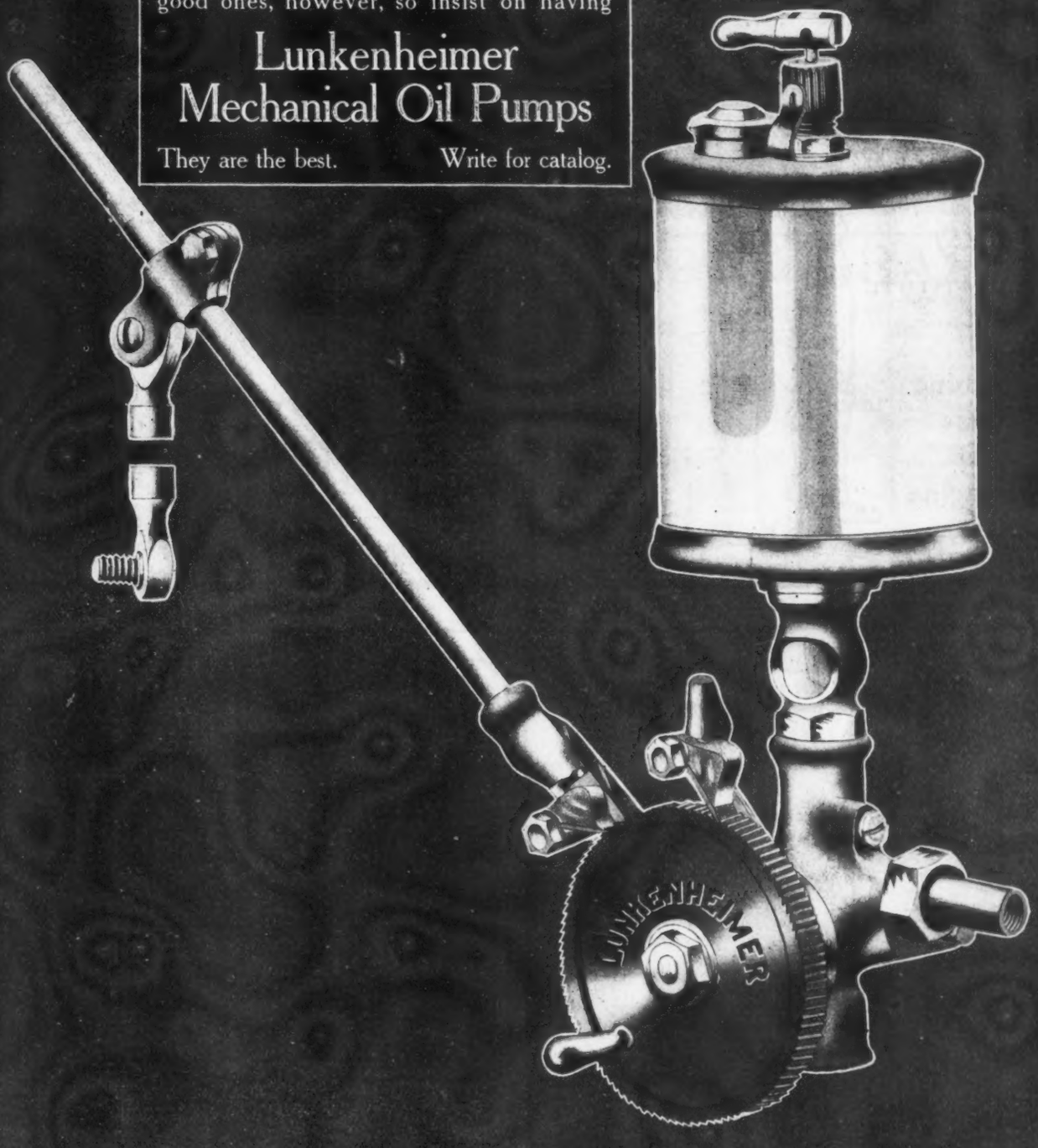
We invite every plant using fire tube boilers to send for a "TORPEDO" on free trial. If it isn't the best cleaner you ever saw, don't buy it. Every engineer should have a copy of our free circular No. 30. "How to Tell a Good Fire Tube Cleaner." For water tubes, send for circular No. 54 on straight tube, or No. 56 on curved tube "DEMON."

THE GENERAL SPECIALTY CO., 887 Niagara St., Buffalo, N. Y.

It has been fully demonstrated that good Mechanical Oil Pumps are by far more reliable and more economical than Hydrostatically Operated Lubricators. The pumps must be good ones, however, so insist on having

Lunkenheimer
Mechanical Oil Pumps

They are the best. Write for catalog.



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Largest Manufacturers of High Grade Engineering Specialties in the World

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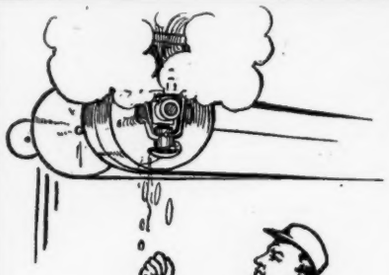
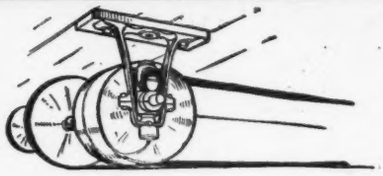
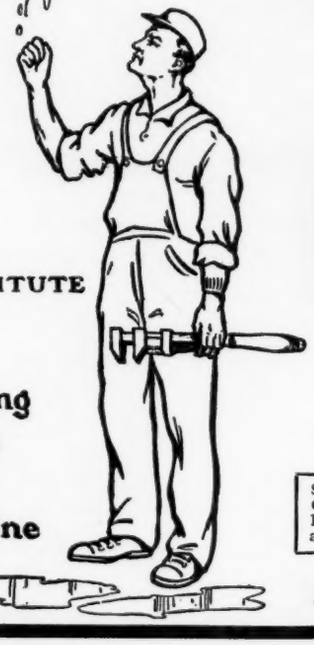
ALBANY GREASE







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Send for FREE sample cup and can of "Albany Grease," giving size of tap for cup, depth of oil hole from top of cap to journal, where to be used and firm's name.

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Some One

of our 337 different styles and sizes of sight-feed lubricators will fill any requirement you may have.

When ordering, insist on getting the genuine Detroit.

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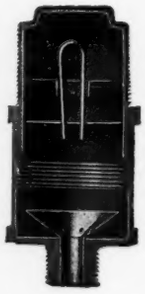
Detroit, U. S. A.

The "Philadelphia" Grease Cup



Automatic application of grease to the bearing without the use of spring compression. : : : :

Nature Supplies the Feeding Force in the Form of Compressed Air. : : : : :

With many thousands of the "Philadelphia" Grease Cups in successful operation, on machinery of almost every description, we offer a system of lubrication which, for simplicity, cleanliness, economy, reliability and efficiency has no equal.

The "Philadelphia" Cup is not merely "as good as any other:" IT IS THE BEST, and we are prepared to prove our claim for actual superiority. There are more reasons for its practical success than we have room to mention here.

Write for catalogue and full information.

The Philadelphia Lubricator & Manufacturing Co.
The Bourse (Exhibition Dept.), **Philadelphia, Pa.**

A Little Graphite Saves A Lot of Oil

By using small quantities of flake graphite, with either oil or grease, you can make the nearest approach to the zero of friction. This obviously means less wear on all friction surfaces, greater durability of all bearings.

DIXON'S Flake Graphite

in addition to saving lubricant and prolonging the life of all rubbing surfaces, increases efficiency. By reducing the friction load it enables the plant to turn out the same quantity of work with a smaller amount of generated power.

Write for Free Sample of Can No. 94-C.

JOSEPH DIXON CRUCIBLE COMPANY
JERSEY CITY, N. J.

JEFFREY
Pivoted Bucket
CONVEYOR
HANDLING
Coal and Ashes in Power Plant

GRAB BUCKETS, STORAGE BINS, CRUSHERS, SCREENS, Etc.

The Jeffrey Mfg. Co.,
Columbus, Ohio, U. S. A.

New York Chicago Boston
Pittsburg Denver Charleston
Knoxville St. Louis Montreal

REAGAN GRATES

The grate which carries with it a GUARANTEE to evaporate 25% more water than any other grate or stoker in the market under similar conditions or no money.

Adopted by the Boston and Northern Street Railway Co., and the Boston Elevated Railway Co., Boston, Mass.

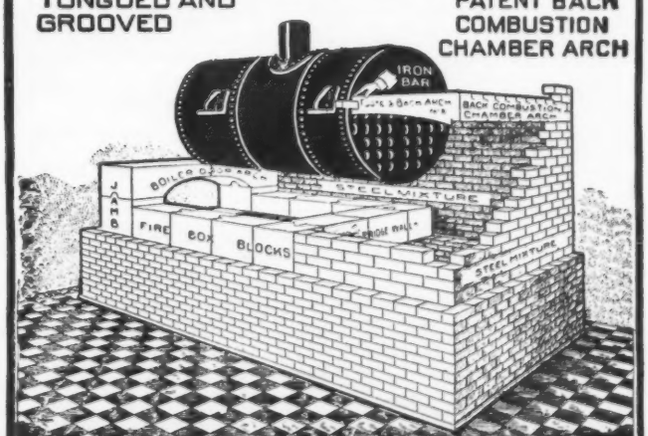
REAGAN GRATE BAR CO., 209 North Front Street, PHILADELPHIA, PA., U.S.A.

"STEEL MIXTURE"

BOILER DOOR ARCHES AND FIRE BOX BLOCKS

TONGUED AND GROOVED

PATENT BACK COMBUSTION CHAMBER ARCH



MANUFACTURED BY
McLEOD & HENRY CO.
TROY, N.Y., U.S.A.
BRANCH OFFICE, 1402 BROADWAY, NEW YORK CITY.

A Perfect Water Seal Prevents Loss of Steam

Once properly set the *Morehead Non-return Steam Trap* requires practically no attention. No valves, floats or buckets inside and consequently no necessity for removing plates or covers of any kind. Catalog?

Morehead Manufacturing Company, 1051 Grand River Avenue, Detroit, Mich.

"SIROCCO"
TRADE MARK

FANS AND BLOWERS

BUILT ON THE TURBINE PRINCIPLE

SIROCCO ENGINEERING CO., 138 Cedar Street, New York

CONTRACTORS.
CENTRAL STATION HEATING.

Write for valuable information.

AMERICAN DISTRICT STEAM CO.,
Lockport, N. Y. Toronto, Can. Chicago.

Wing's Turbine Blower

FOR FORCED DRAFT

Most Efficient Most Compact Catalog?

L. J. WING MFG. CO., 90 West Street, NEW YORK

ANY TYPE OF BOILER

The Murphy Automatic Smokeless Furnace

burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

MURPHY IRON WORKS, 5 Walker St., DETROIT, MICH.

UNITS OF ANY SIZE

MARTIN GRATES

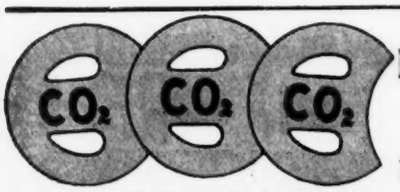
Martin Anti-Friction Rocking Grates will burn slack coal and get the same steam results as ordinary grates do with best lump coal. Catalog tells why.

MARTIN GRATE COMPANY, 281 Dearborn Street, CHICAGO.

PREVENT SMOKE

Write to us for descriptive matter relating to a device that is mechanically correct, simple in construction, absolutely automatic, and its effectiveness in preventing smoke from Bituminous coal under any and all conditions has been fully demonstrated.

CLIMAX SMOKE PREVENTER COMPANY
205 Equitable Building, Boston, Mass.



C-O-Two Tile
FIRE ARCHES
Any Rise, Any Span,
Air Baffle Mixing System
produces
RESULTS

C-O-TWO FURNACE COMPANY, Syracuse, N. Y.

THE ONLY METAL POLISH

that works quick and easy and keeps its lustre. Holds old trade and makes new. IT DOES NOT DETERIORATE. Established 16 years.

3-Ounce Box for 10 cts. 5-Pound Pails, $1.00

Sold by Agents and Dealers all over the world. Ask or write for Free samples. Highest Award, Chicago, '93; St. Louis, '04.

GEO. W. HOFFMAN, Expert Polish Maker,
295 E. Washington St., INDIANAPOLIS, IND.
Branches—New York, Chicago, San Francisco.

GREEN TRAVELING CHAIN GRATES

AUTOMATIC SELF CLEANING SMOKELESS

GREEN ENGINEERING CO.
COMMERCIAL NATIONAL BANK BLDG., CHICAGO.

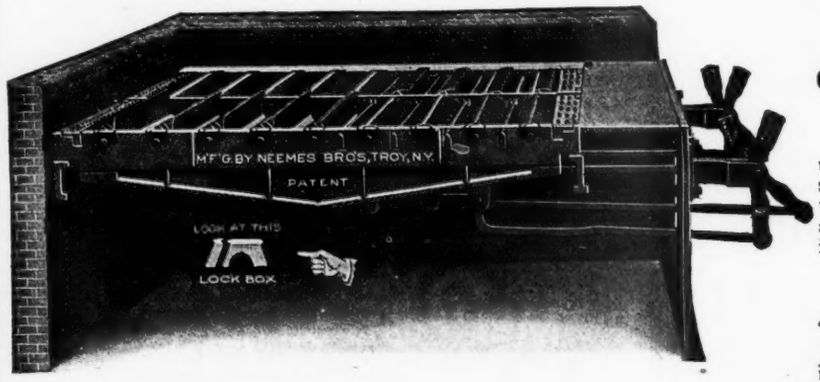
GENERAL FOUNDY WORK A SPECIALTY

Over 7500 Hammel Oil Burners

In use under Stationary Boilers, Locomotives, Kilns, Etc.

Write for Circular of Hammel Patent Furnace for Water-Tube Boilers

HAMMEL OIL BURNER CO.
609 North Main Street, LOS ANGELES, CAL.



NEEMES BROS.

IMPROVED

Clinker Cutting, Shaking and Dumping Grate

unlike all other grates will cut from both sides of the shaker alike. Makes more steam with cheaper fuel and less of it. A slight agitation shakes out the ashes or a full opening dumps everything into the ashpit. *Write.*

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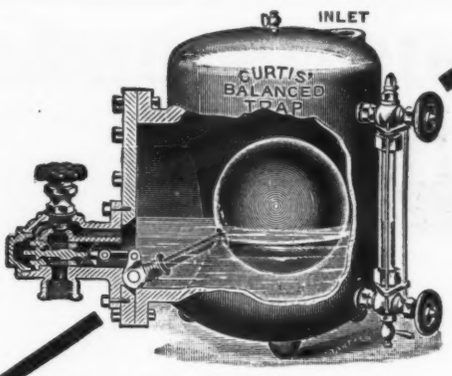
C. W. VAN BLARCOM, Room 533, Terminal Bldg., 30 Church St., Agent for New York City and vicinity BABCOCK & WILCOX, Ltd., Montreal, Canada, Sole makers for Canada BURKE ENGINEERING CO., 511 Industrial Bldg., Providence, R. I., Sole Agents for the New England States.



That Engineer Is Getting Satisfaction

who has a CURTIS BALANCED TRAP working for him. Its sure, positive action and absolute accuracy make it invaluable wherever a trap is needed—absolutely reliable under all conditions, works under any pressure up to 250 pounds.

Do you know the CURTIS SPECIALTIES? Write for copy of latest catalog.

Julian d'Este Company
24 Canal St., Boston, Mass.

You Can Require More of Your Plant

and not be disappointed when you have installed Kitts Steam Specialties

Steam Traps Pump Governors
Reducing Valves
Fan Engine Regulators
Safety Water Columns
Damper Regulators Low Water Alarms
Safety Feed Water
Low Pressure Boiler Feeders Regulators
Vacuum Pressure Reducing Valves

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KITTS MANUFACTURING CO.
OSWEGO, NEW YORK

If Your Chimney Smokes, It's Wasting Your Money.

The Wilkinson Automatic Stoker And Smoke Preventer

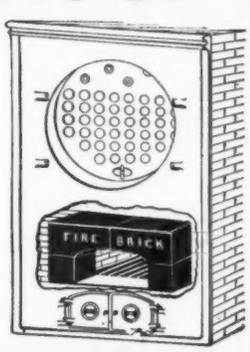
will stop the waste and show a 15% decrease in fuel costs, save stokers' wages, prevent expansion and contraction which cause so much damage to your boiler and insure cleanliness otherwise impossible. *Write.*

The Wilkinson Manufacturing Co.,
Bridgeport, Montgomery County, Pa.

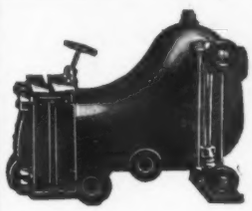
HEAT PROOF

The heat resistance of our fire brick is wonderful. We fit every type of boiler setting.

Write for catalog and prices.



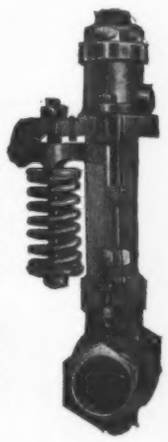
Presbrey Fire Brick Works,
Taunton, Mass.



McDANIEL STEAM TRAPS

are especially adapted for draining steam separators and high pressure mains. Also good for steam heating. All working parts are attached to the bonnet, and are removable with it. Valve outlets are large, to give rapid discharges of condensation.

Watson Steam Pump Governor



should be used on all steam pumps where a fixed discharge pressure is desired.

The construction permits of easy access to the stuffing box for removing packing, and the spring can be adjusted or entirely removed without interfering with any other part of the valve. Any practical man will readily see its advantages.

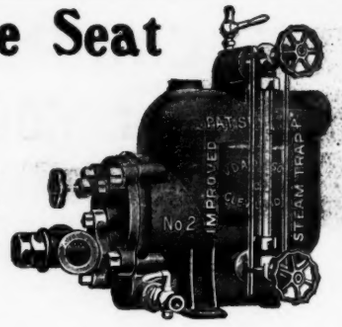
All our goods are made in our own factory and tested before shipping. We guarantee them to give perfect satisfaction. Established 1878.

Send for Catalogue.

Watson & McDaniel Co.,
148 North 7th Street, Philadelphia, Pa.

The Valve Seat

of the Anderson Improved Steam Trap can be removed from the outside without breaking a steam joint or pipe connection.



BOOKLET ?

THE V. D. ANDERSON CO.,
1935 WEST 96TH ST., CLEVELAND, OHIO.

THIS IS OURS!

The celebrated **GEIPEL STEAM TRAP,** made in seven sizes and for all pressures.

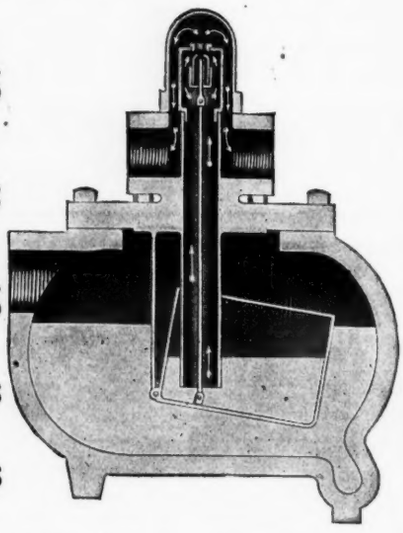
CIRCULARS ON REQUEST.

JOHN PLATT & COMPANY,
99 Cedar St., New York.

4/S LOOK

for our sign in every issue of this magazine, also send for our *CATALOG "A"* of

STEAM TRAPS
Reducing Valves
VACUUM TRAPS
Pump Governors
Feed Water Regulators
ETC.

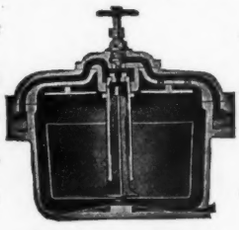


THE STRONG, CARLISLE & HAMMOND CO.
342 Frankfort Ave., CLEVELAND, O.

54 No. 6th St., Philadelphia. 88 Broad St., Boston. 261 Centre St., New York.

Nason Manufacturing Company's STEAM TRAPS

SPECIFY:
Class B for pressures less than 20 lbs.
Class C for pressures 20 to 70 lbs.
"Sidelug" for pressures 40 to 150 lbs.

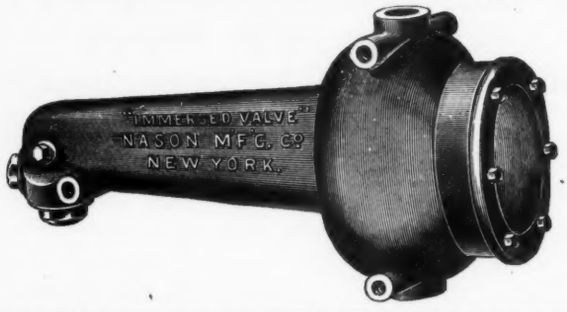


THE TRAP THAT ALWAYS "FILLS THE BILL"

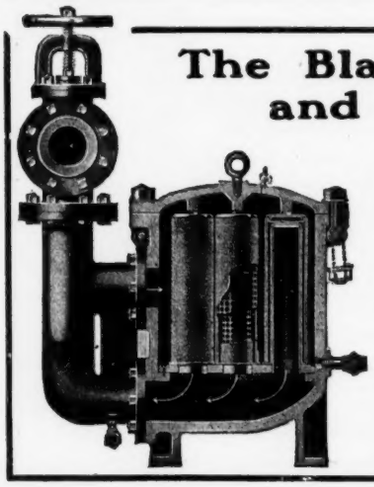
Nason Manufacturing Company's "Immersed Valve" Boiler Feeder

FOR LOW PRESSURE STEAM BOILERS

As a safeguard against the destruction of boilers through careless handling they are a necessary adjunct. Special Catalog.



NASON MANUFACTURING COMPANY
71 FULTON STREET, NEW YORK



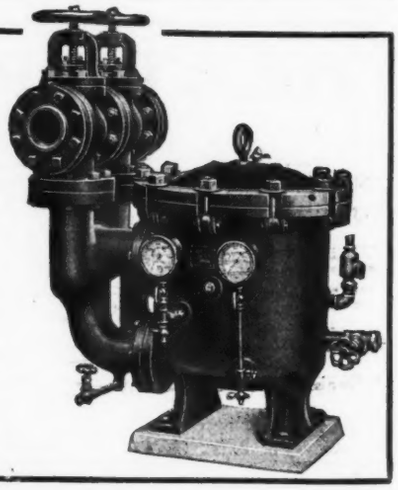
The Blackburn-Smith Filter and Grease Extractor

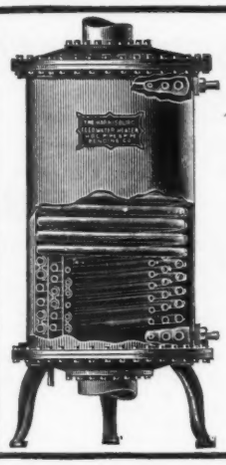
is practically two filters in one, for every drop of water must pass through two separate and distinct Terry filtering surfaces If your feed water contains sediment, slime or particles of oil or grease, this filter will pay for itself by stopping repair bills and saving coal.

The Blackburn-Smith Filter can be cleaned or removed almost entirely without touching the feed line, and as the filtering media can be used over and over the first cost is practically the last.

Tell us your feed water troubles and we will tell you the remedy.

JAMES BEGGS & CO.
106 Liberty St., New York City





HARRISBURG FEED WATER HEATER

of Pure Seamless Copper Coils

Guaranteed to be the most effective, most durable and cheapest heater manufactured.

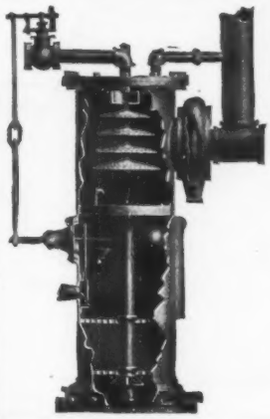
COPPER, IRON AND BRASS PIPE

Coils and Bends of any desired shape. Manufacturers of High Grade Wrought Iron Pipe, Black or Galvanized. Write for descriptive catalog.

Manufactured by

The Harrisburg Pipe & Pipe Bending Co.

950 Herr Street, HARRISBURG, PA.



OUR TWINS

EITHER ONE WILL SAVE 15% of fuel and preserve the boiler.

Write for Prices, Etc.

The Sims Co.,

ERIE, PA.

Branch Office:
136 Liberty St., New York,
Tel., 529 Cortlandt.

WET STEAM

IS POISON TO YOUR ENGINE

A Gardner Separator between your boiler and engine is a perfect antidote for wet steam. Increase your engine efficiency and decrease expenses.

ASK FOR THE BOOK.

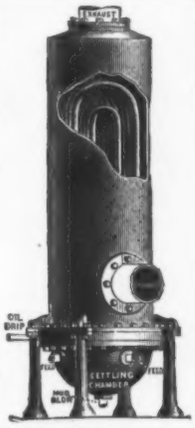
The Gardner Governor & Separator Company,
Quincy, Illinois.

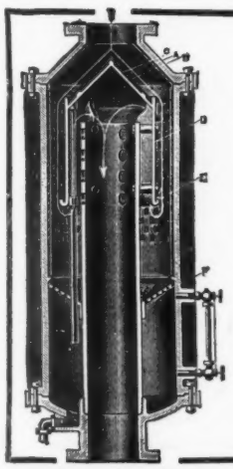
How Long Have You Lost The Cost Of Exhaust

Patterson-Berryman Feed Water Heaters

will make you wish you had installed them sooner and saved all the money you have been wasting on high fuel bills, repair costs and scale removal. Write.

Frank L. Patterson & Co.,
28 Cortlandt St., New York, U. S. A.





DON'T

buy a steam or oil separator without sending for catalog describing

SWEET'S

and then *read* and *think* about it and you'll order one: 6000 in use; deliver steam 99.8 dry; takes out all the oil, that is 99%.

DIRECT SEPARATOR COMPANY
712 South Geddes Street SYRACUSE, N. Y.

BAUM SEPARATORS

ARE BEST for Live and Exhaust Steam.

Positively Guaranteed.

"I take pleasure in stating that this department has used the Baum Separators for a considerable time, and has found them to be all you claim for them and are satisfactory in every respect."—The Superintendent of Public Buildings, Albany, N. Y.

Send for new Catalogue and prices.

Hershey Machine & Foundry Co.

85 Water Street, Boston, Mass.
MANHEIM PA., U. S. A.

W. G. Ruggles Co., 54 High St., Boston, Mass.
R. D. Bliss, 40 Dearborn St., Chicago, Ill.

OF WHAT USE ARE BAFFLE PLATES

in a separator anyway?

They don't arrest the water when it comes in a rush except to break it into fine particles that are the more easily carried off with the steam

Therefore the

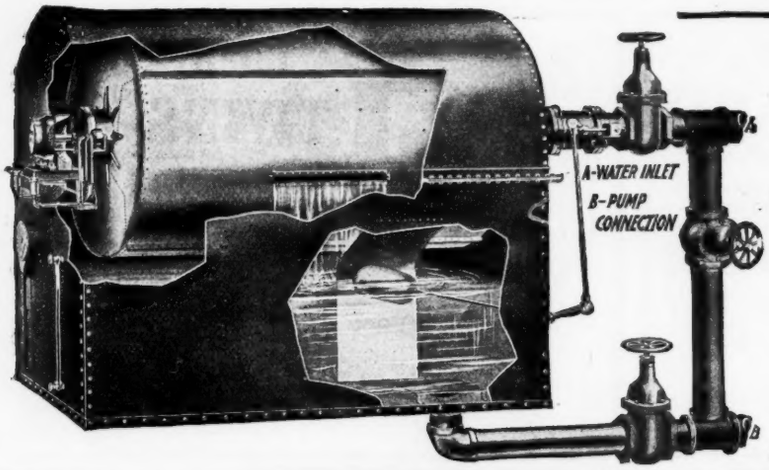
STRATTON SEPARATOR

has none of them.

It throws the water out of the steam by centrifugal force and lets only the pure dry article pass to the engine.

The STRATTON always does the work when others fail.

Goubert Manufacturing Co.,
No. 90 West Street,
NEW YORK CITY, N. Y.



What Are Your Boilers Doing?

Are you getting the best economy?
Is your coal best fitted for your purpose?
Can You Tell Your Evaporation?
A
DETROIT METER
Will Give You a Continuous Record of Your Boiler Feed Water
Built in all sizes for all requirements of power plants, heating companies and for measuring any liquid.

CENTRAL STATION STEAM COMPANY
Detroit, Mich., U. S. A.
SEND FOR CATALOG.

It's Like Finding Money

to install the LOEW FEED WATER HEATER. It gives the exhaust steam a *financial value* and reduces fuel bills about 15%.

Some distinctive "Loew" advantages are: The thorough mixing of the water, thus equalizing the temperature. The 6-pass feature, which means that the water passes *six times* through the exhaust steam. The absence of unequal expansion or strain, the ease of cleaning and the total elimination of leakage.

WRITE FOR CATALOG.

The Loew Mfg. Co.,
Cleveland, Ohio.

It's cheaper to Build a House than to Warm a Whole County

Single Shell Heaters, instead of keeping the heat in by an outer housing, try to warm the whole county.

Baragwanath Steam Jacket Feed Water Heaters

operate in the common sense, economic way which practice has proven best they enclose the heater with walls as a furnace is inclosed by house.

WRITE.

WM. BARAGWANATH & SON,
54 West Division St.,
CHICAGO, ILLINOIS, U. S. A.
Thos. B. Whitted, Piedmont Bldg., Charlotte, N. C., Southeastern Manager.

The Reilly Multicoil Heater

Used by the U. S. Government because it is the lightest, most efficient, and the best designed feed water heater.

It costs no more than less efficient types. It gives better and longer service than the most expensive. We recommend using a thermometer to prove our guarantees.

THE GRISCOM-SPENCER CO.
90 West Street, New York
STEAM BOILERS — ENGINES — TANKS
THE REILLY GREASE EXTRACTOR AND FEED WATER FILTER

Eclipse Live Steam Purifiers

heat your feed water to a temperature which causes all scale forming impurities to separate out before the water reaches the boilers. Absolute guarantee.

Catalog?

The Eclipse Feed Water Heater & Purifier Company,
Oshkosh, Wisconsin.

Metal-to-Metal Joint ECONOMIZERS

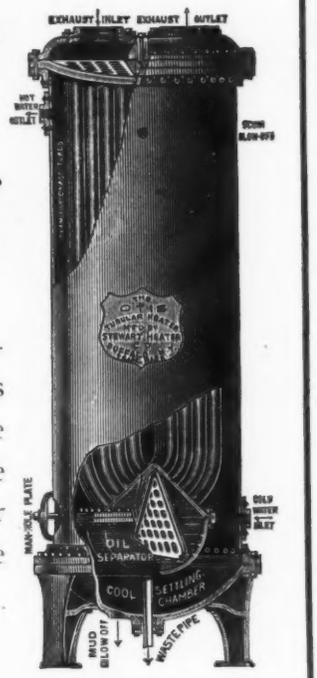
B. F. STURTEVANT CO., Boston, Mass.
General Office and Works—Hyde Park, Mass.
NEW YORK PHILADELPHIA CHICAGO CINCINNATI LONDON

No Dirt Settles On The Tube Plate

as you see by the cut the tube plate of

The Otis Tubular Feed Water Heater

is not flat, consequently the sediment does not lodge among the tubes but falls to the cool settling chamber where it may easily be blown off.



Write for full information.

THE STEWART HEATER CO.
45 E. Delavan Ave., Buffalo, N. Y.

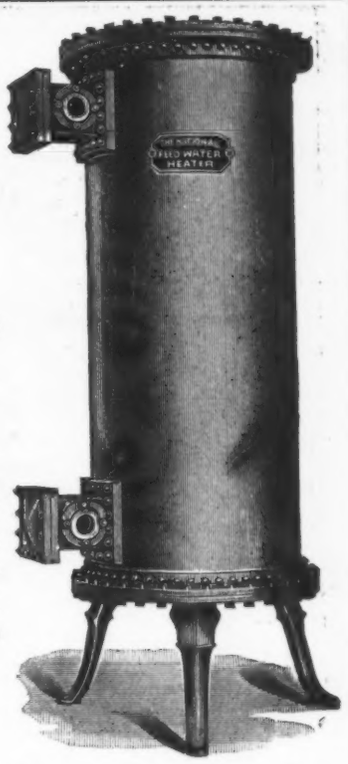
The National Feed Water Heater has a

Shell Area Six Times That Of Its Exhaust Pipe

consequently there can be no back pressure.

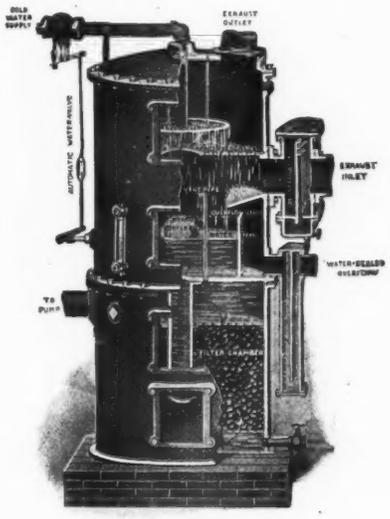
Unlike other heaters it permits no contact of water with the shell, has no inside joints or straight tubes and rarely costs anything for repairs.

CATALOG ?



The National Pipe Bending Co.,
175 Lloyd St., New Haven, Conn.
120 Liberty Street, New York.
54 High Street, Boston, Mass.

THE WHITLOCK OPEN EXHAUST Feed Water Heater and Purifier

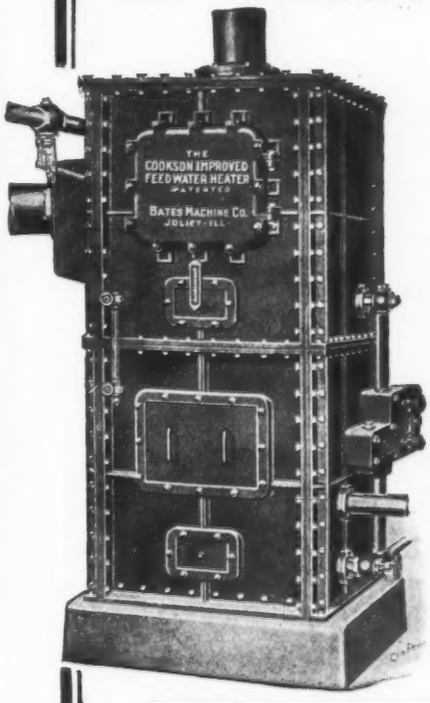


Perfect Oil Separation. Easily Cleaned. The Highest Possible Temperature in the Feed Water.

Manufactured by

THE WHITLOCK COIL PIPE COMPANY
HARTFORD, CONN.
New York Office—Singer Building, 85 Liberty Street.

COOKSON STANDARD ALL CAST IRON FEED WATER HEATERS



Highest Temperature and Positive Purification of feed water.

Perfect Separation and Removal of Oil.

Automatic Control of Cold Water Supply.

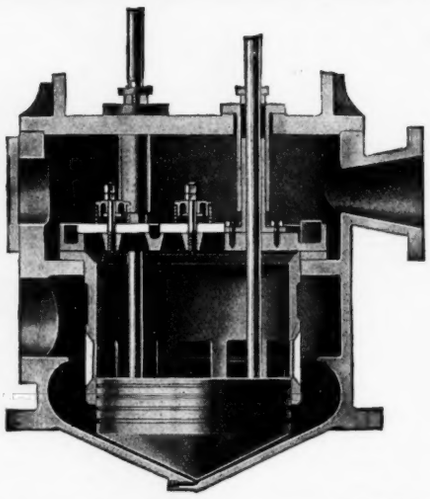
Dry Steam for Heating Purposes.

Finest Grade Special Fittings.

Lime Catching Pans. Especially Adapted for use with Heating Systems, Dryers, Etc.

Write for our new Heater Catalog.

BATES MACHINE COMPANY
Sole Manufacturers **Joliet, Illinois**



An Air Pump With No Foot Valves And No Bucket Valves

has less to get out of order and to be kept in repair than an air pump which contains such parts.

But this is not the main reason why the Edwards Pump is better by not having such valves. With no foot valves, the air and vapors in the Condenser can flow directly into the pump chamber without let or hindrance. There are no valves to be lifted and no head of water on the valves to be overcome. The air and vapors flow freely and at once into the vacuum created by the descent of the plunger and they are further assisted by the aspirating action of the Condensation injected in above the plunger just before the latter rises and shuts off the ports.

At the end of the stroke the air and vapors are forced out through the head valves, the water passing out first so that no gas is left in the clearance space. Even the clearance space filled with water is reduced to the lowest possible minimum, so that upon the descent of the plunger very little gas can be set free by the expansion of bubbles. Any gas left in the clearance space of the vacuum pump must expand to condenser pressure before more gas or vapor can be taken in

The Wheeler Edwards Air Pump accomplishes all that can be done with separate wet and dry pumps of the ordinary type. For proof of this let us give you references to a large number of installations now operating in this country.

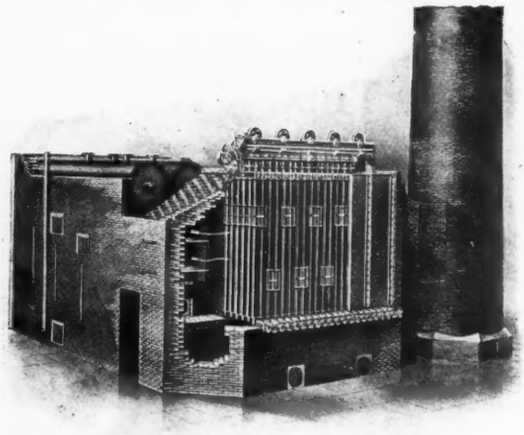
Ask for "Bulletin 3 P."

WHEELER

CONDENSER AND ENGINEERING CO.,

CARTERET, N. J.

(Builders of Wheeler Surface, Wet and Barometric Condensers, Wheeler-Volz Combined Surface Condensers and Feed Water Heater, Wheeler Feed Water Heaters, Barnard-Wheeler Cooling Towers, Wheeler-Edwards Air Pumps, Wheeler Centrifugal Pumps, Wheeler Rotative Dry Vacuum Pumps and Wheeler Multiple Effect and Evaporating Machinery). 10



It Pays to Find a Place for the Green Fuel Economizer

Many people realize that their present boiler plants are wasting a good percentage of fuel, and know further that this fuel could be saved and the capacity of the boiler plant increased by putting in a Green Fuel Economizer. Still they say that they have not room in their boiler house to install an economizer, and they, therefore, put off taking the matter up with us, and the waste of fuel goes on.

This is a mistake. We can usually find a place for the economizer without upsetting the arrangement or interfering with the operation of the existing plant. The economizer requires so little attention that it does not need to be in a very accessible place.

The installation of the economizer is often the only practical way of increasing the boiler capacity without adding to the boiler house. This increase in the capacity is even greater than the increase in economy; for instance, if the boiler efficiency is increased by 13%, the capacity will be increased by 20%.

If you wish to know what we can do in your case, send a sketch showing the lay-out of your boiler plant, and a few particulars, such as the size and number of the boilers, amount of fuel burned, etc., and we will devise a suitable arrangement, and make an estimate which will show you just what can be done, and the possible saving.

For a full account of economizer practice, send for our Treatise, "106 P." If you are putting up a new plant, consult us before your designs have progressed too far for revision.

The Green Fuel Economizer Co.

MATTEAWAN, N. Y.

New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal.

Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines. (155)

KOERTING
CONDENSER

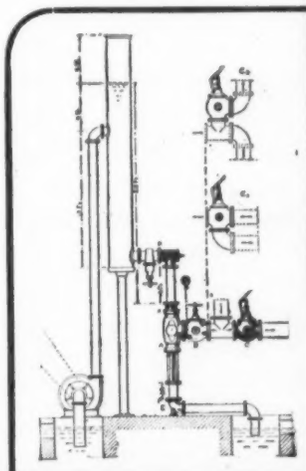
FIRST AID TO INCREASED POWER

VACUUM 93%

The Koerting Condenser can be applied to engines and turbines of any size, and will work with absolute certainty under all conditions of load variation. They are also applicable to evaporators, and other auxilliaries where a high vacuum is required. The air and non- condensable gases are discharged with the water, without the use of air pumps. The actual horse power required for running a Koerting Condenser is less than one-half the power required for a condenser working with air pumps. The only movable part connected with a Koerting Condenser plant is the Centrifugal pump to elevate the water to stand pipe at a head of 20 ft., therefore wear and tear is reduced to a minimum. These condensers maintain a high and steady vacuum independent of load variation.

Write for Catalog 5-A

LITTLE SPACE REQUIRED



SOME ADVANTAGES:

1. Increased Power.
2. No Air Pumps.
3. Full Water Openings.
4. Short Exhaust Pipes---therefore no leak, as is often the case with high built-up condensers.
5. No Moving Parts.
6. Small Space Required.

PROFIT BY OTHER'S EXPERIENCE:

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WM. P. NICHOLS, Supt.

Nasonville, R. I., April 25th, 1905.

Gentlemen:

We are using one of your 6" condensers and have found it entirely satisfactory in every way, giving us a vacuum of 27" to 28" with an increase of 25% power.

Yours truly,

SCHUTTE & KOERTING CO.

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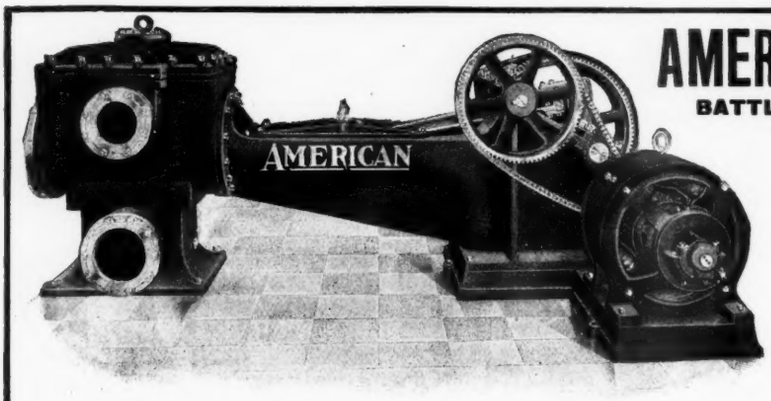

American Electric Driven Vacuum Pump. Silent Chain Drive.

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We make a specialty of VACUUM PUMPS, both STEAM and POWER, for heating systems.

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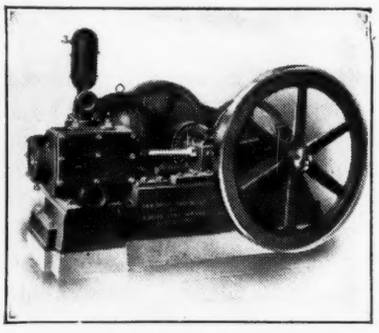
SIMPLEX NOT DUPLEX.

To be simple is to be great.

DuBois Pumps

CONSPICUOUSLY ALONE



DuBois Motor Driven Pump

IN SIMPLICITY OF DESIGN

These pumps require less attention and give more effective results than any other pumps of similar type. Complete details on request.

DU BOIS IRON WORKS
Established 1877
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The Deane Independent Condensing Apparatus shown here,

is one of the condensers which are today condensing steam from several thousand engines in power houses of all kinds.

Vertical Fly-Wheel Condensers.

Vertical Direct Acting Condensers.

PRICES furnished upon application.

If thinking of installing a condensing apparatus, why not specify a Deane Condenser. Our installations give results and not trouble.

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Dean Bros. Steam Pump Works

INDIANAPOLIS

Simple Plunger Pump

Simple and Duplex Boiler Feeders. Jet and Surface Condensers. Power and Electric Pumps.

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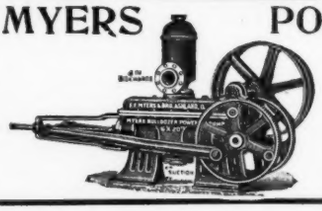

Adapted especially for gas engines, motor and belt powers, in harmony with present requirements.
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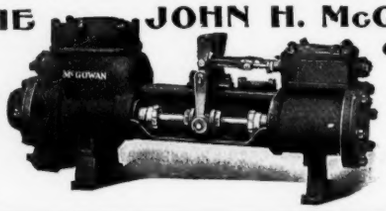

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Single Duplex and Fly-Wheel Types
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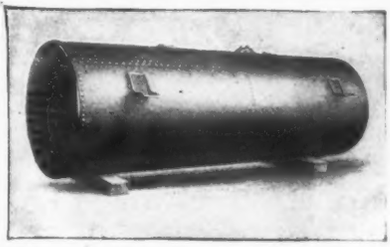

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HIGHEST GRADE

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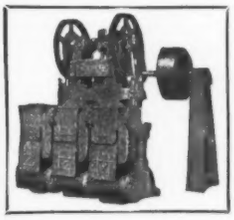

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PUMPS FOR ALL REQUIREMENTS.

PISTON HYDRAULIC *DEEP WELL PLUNGER* *VERTICAL POWER*

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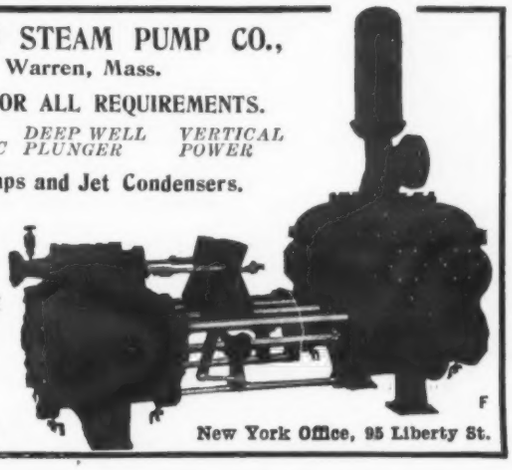

CATALOG ?

F

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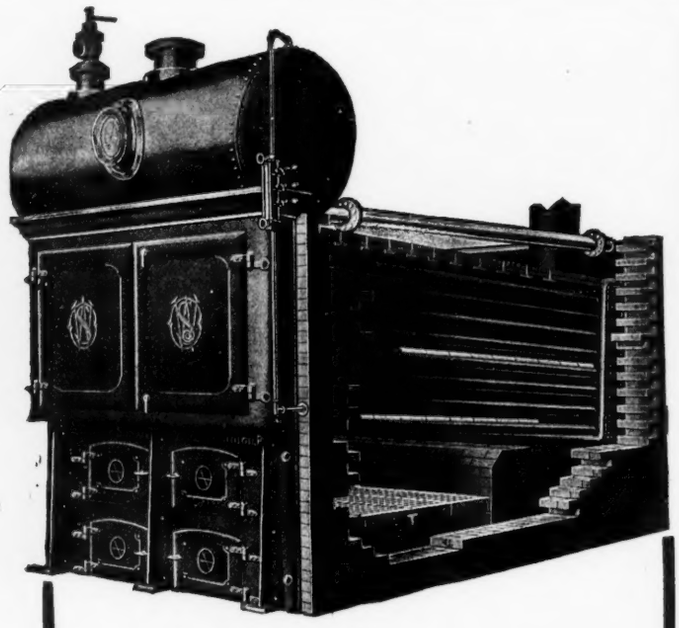

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Built for any pressure from 125 to 300 pounds. Meets all the high duty requirements of modern triple and quadruple expansion and compound engines. Perfect circulation, remarkable economy, and freedom to expand and contract, are features.

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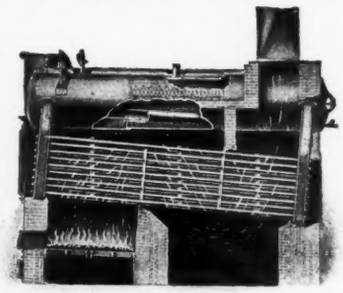

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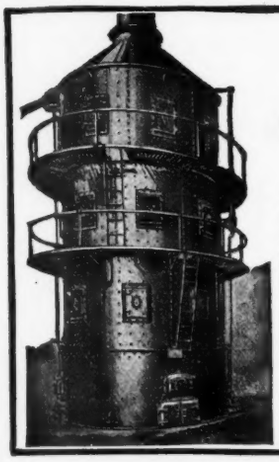

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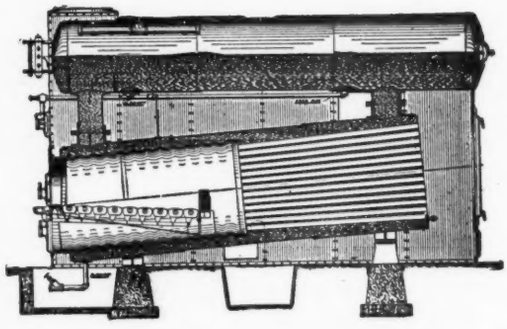

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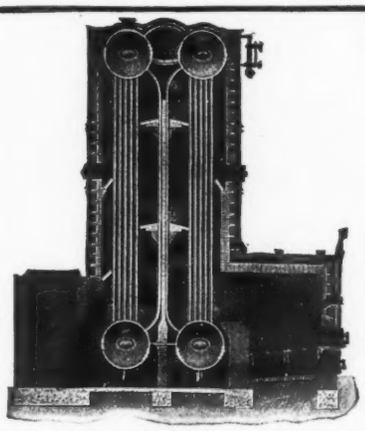

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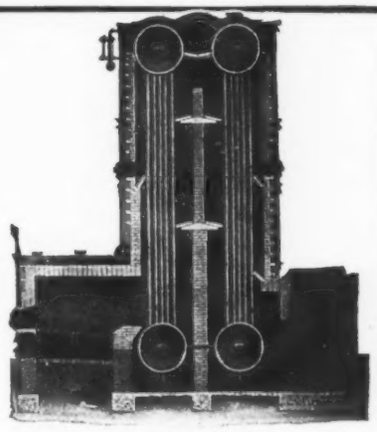

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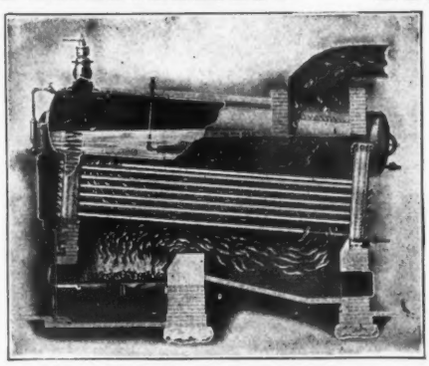

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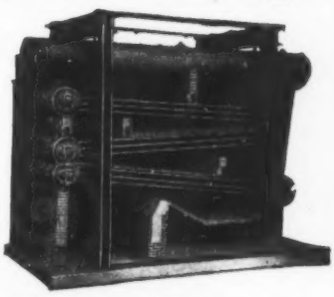

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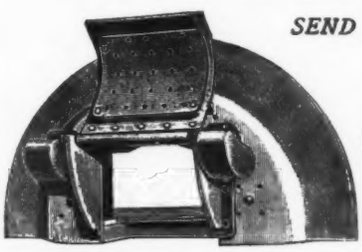

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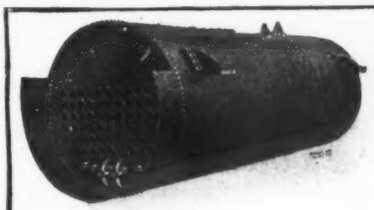

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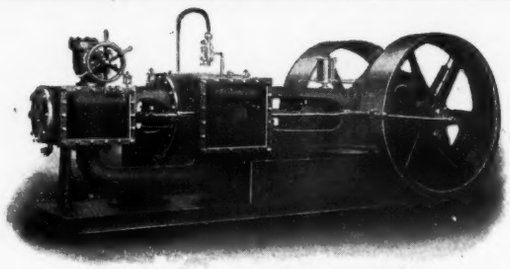

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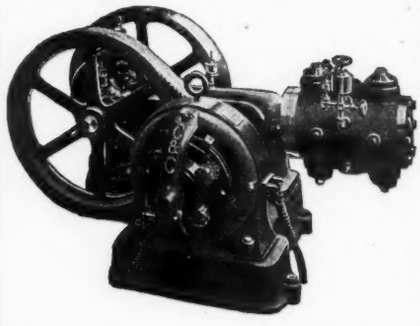

when it's working hard. No need to add to the temperature when a motor runs the outfit—select a

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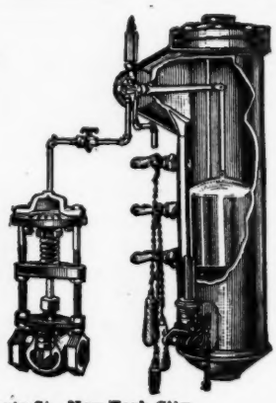

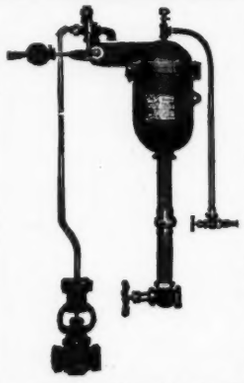

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for steam boilers was the first in the *field,* and has the longest and best record of any of these devices.

Costs Less to Operate and Maintain

Constructed on a different and better principle than any other.

Investigate it and the

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A guarantee from a responsible firm with every machine.

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Individual Electric-Motor Drive

Competition is keen

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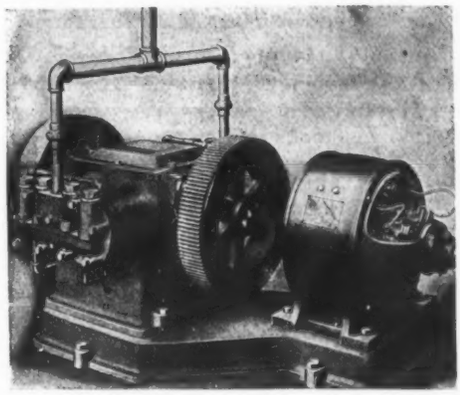

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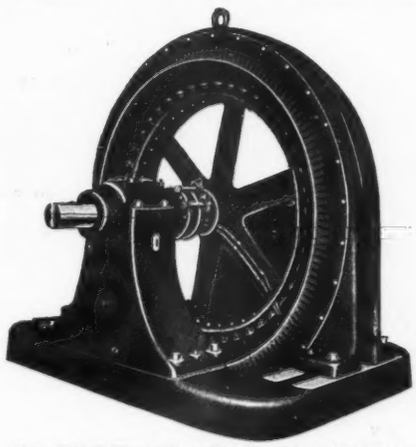
Canada—Canadian-Westinghouse Co., Ltd., Hamilton, Ont.

Mexico—d. & O. Braniff & Co., City of Mexico.

FORT WAYNE ELECTRIC WORKS

Good Alternators



Type T R E Three-Phase Engine-driven Alternator.

give no trouble from regulation—perhaps regulation is not particularly noticed—because it *is* good. Poor regulation would be noticed at once—with annoyance. Every chance for poor regulation is eliminated from Fort Wayne alternators by correct design and particular construction of those parts which in any way might affect regulation.

710

SALES OFFICES: Main Office: **Fort Wayne, Ind.** IN MOST LARGE CITIES

TRIUMPH INDUCTION MOTORS

HIGH EFFICIENCY
HIGH POWER FACTOR
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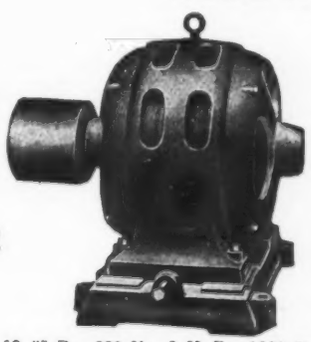

1 TO 75 H. P.

10 H. P., 220 V., 3 H. P., 1200 R. P. M.

Triumph Electric Co.,

Main Office and Works:
CINCINNATI, OHIO

BRANCHES IN ALL LARGE CITIES

SOUTHWARK FOUNDRY AND MACHINE CO.

PHILADELPHIA, PA.

Our type of BLOWING ENGINES for Blast Furnaces and Bessemer Steel Works is largely used in the United States and Europe.

Built of vertical and horizontal pattern; simple and compound steam ends; and air cylinders fitted with our patented grid-iron valves which make it possible to operate at higher speeds than with the usual form of air valve.

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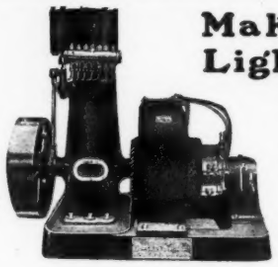

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With this machine installed in your plant you can produce your electric lighting at much less cost than you can buy it from the mains and with practically no increase in the cost of steam and labor. Requires little attention, is sufficiently compact to be readily installed in small space and will outlast any other on the market. Easily accessible and operates with perfect steadiness and without noise.

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YOU CAN DEPEND ON NORTHERN APPARATUS ALWAYS.

Our machines operate constantly—sometimes twenty-four hours a day for years—under the severest possible operat ng conditions. Northern equipments endur in moist or dusty localities. They give constant, economical power and light ¶Whe her your service is severe or easy you w'll find Northern machines well suited to your work. At any rate you ought to investigate this to prove that we are right or wrong. Get Bulletin 838 and tell us what you want to do with electric power. 895

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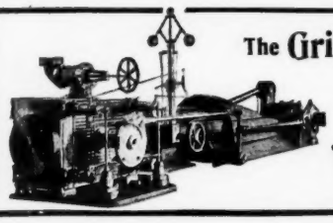
Standard and Special Electrical Machinery.



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Established 1840

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Manufacturers of

The Ohio Corliss Engine and Hoisting Engines

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MAINTAIN THEIR ECONOMY AND SUPERIOR RUNNING QUALITIES.

ASK ANY USER

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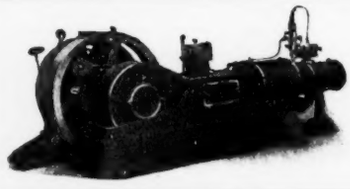

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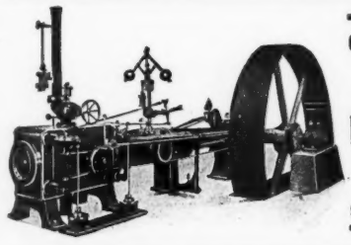

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Refrigerating and Ice Making Machinery

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For Reliability and Economy.

Built by

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We Manufacture

AN ECONOMICAL AND DURABLE ROTARY ENGINE

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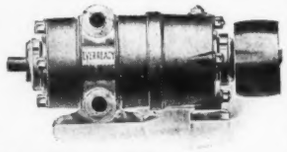

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This cut represents our new set of 20 tools gotten up for use in the engine room. Strictly high-grade tools with all the good points of toolsmithing in their make-up. Conveniently arranged in finished Oak Case and every tool is guaranteed.

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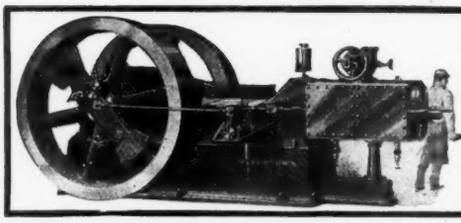

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for every power purpose. Ask for Catalog.

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The Allan Metal for Pistons and Bearings.

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ACCURATE REGULATION FOR ELECTRIC SERVICE-AUTOMATIC CUT-OFF AND RITES FLY-WHEEL GOVERNOR

A.H.ALBERGER COMPANY

45 TO 600 H.P. USING NATURAL GAS
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THE CHEAPEST POWER IN THE WORLD

GAS ENGINES, GAS PRODUCERS
COMPLETE PLANTS INSTALLED

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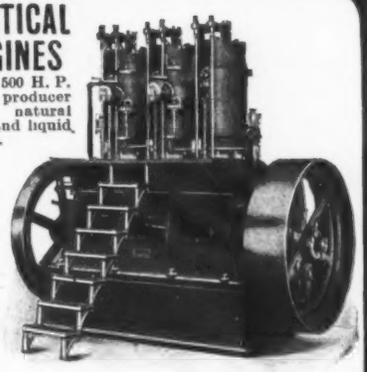
20 to 500 H. P. for producer gas, natural gas and liquid fuels.



Foos Engines have a proven thermal efficiency of 28 per cent. Foos engines will pay for themselves in fuel saved.

Complete Waterworks and Electric Plants

Ask for Catalog K, and let us help you to investigate these surprising claims.

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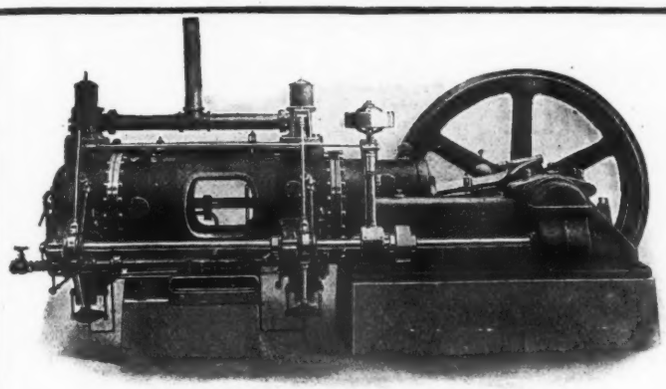
Springfield, Ohio.
Largest Exclusive Gas Engine Plant in America.



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Horizontal and Vertical
Types up to 700 H. P.

NOT AN EXPERIMENT

Economy and Reliability Have Been Demonstrated by Actual Service

FULLY GUARANTEED

For All Street Railway, Electric Light and Power Requirements

STRUTHERS-WELLS COMPANY,
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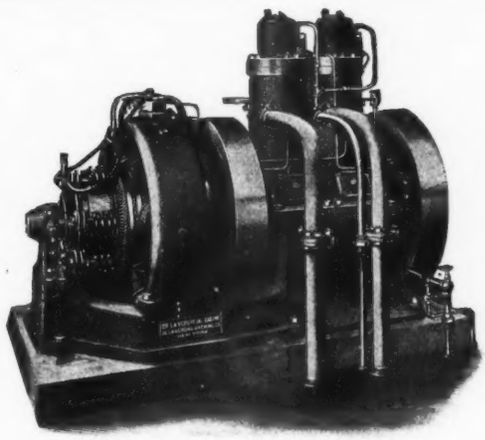

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OIL ENGINES

are cheaper, simpler, more compact than any other motive power. 8 H. P. hours per gallon of cheap oil.

5315 H. P. used by Baldwin Locomotive Works

The "De La Vergne" Vertical two-Cycle 4 to 25 H. P.
"Hornsby-Akroyd" Horizontal Four-Cycle 2 1-2 to 250 H. P.

DE LA VERGNE MACHINE CO.

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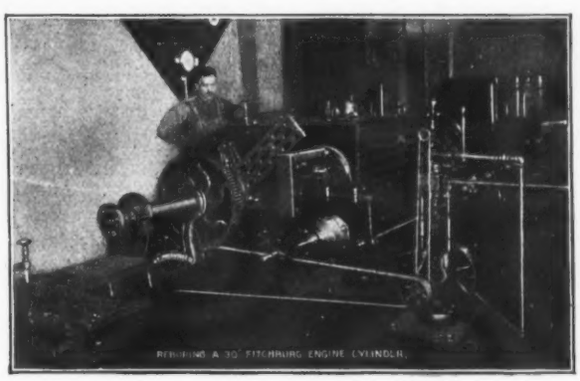

What's the use of taking your engine apart and sending the piece away to be repaired?

We'll come direct to you and fix the trouble in short order. Our charges are reasonable, and you get the benefit of **expert service.** We make repairs **overnight** and rebore cylinders up to 120″ in position.

Ammonia Cylinders Indicated.

H. B. UNDERWOOD & CO.,
ESTABLISHED 1870.
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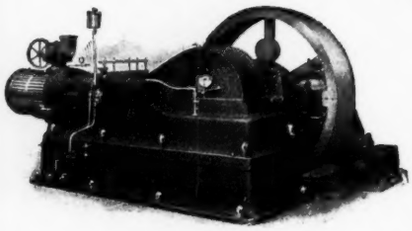
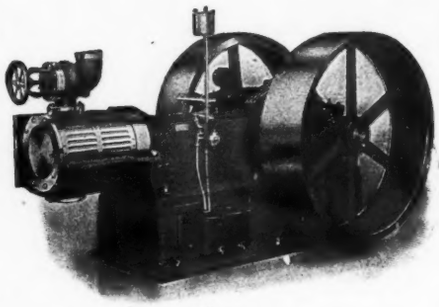


SIDE CRANK TYPE

Skinner Engines

CENTER CRANK
SIDE CRANK
SINGLE and FOUR VALVE

Skinner Engine Co.,
Erie, Pa.



CENTER CRANK TYPE

BUCKEYE ENGINE COMPANY,

SALEM, OHIO

BUILDERS OF HIGH CLASS

STEAM AND GAS ENGINES

HIGH IN DUTY, SUPERIOR IN REGULATION
AND
ABSOLUTELY RELIABLE

CORRESPOND WITH US BEFORE PURCHASING
CATALOGS ON APPLICATION

"ERIECO"

The Perfect Alignment

of this engine results from the fact that the frame is bored, the bearings for pillow blocks are spotted and the end of the frame is faced all at one setting. Write for further details.

CATALOG?

Erie Mfg. & Supply Co.
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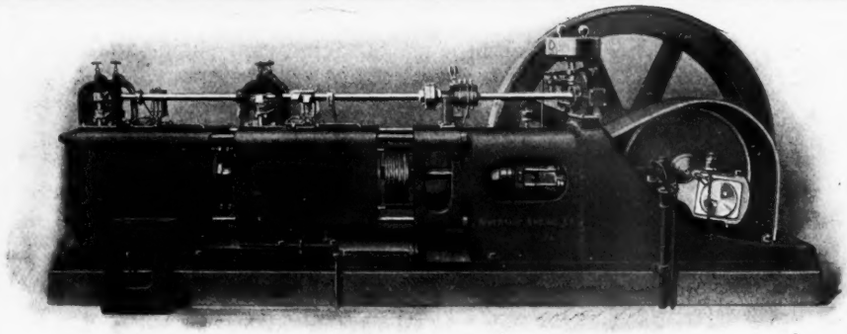

RIVERSIDE HEAVY DUTY SINGLE ACTING TANDEM GAS ENGINE (Class C)
SHOWING QUICK METHOD OF EXPOSING PISTON AND RINGS.

Simplicity and Accessibility

due to valve gear being all on top and of the simplest possible form; the divided cylinder permitting piston and rings to be exposed in about the same length of time required to remove the cylinder head from most engines; are features found only in the

Riverside Heavy Duty Gas Engine

Built in 12 types, 72 different sizes ranging from 10 to 2500 H. P., to operate on any of the power gases. We also build a complete line of gas driven air and gas compressors.

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Robt. Wetherill & Co., Inc.

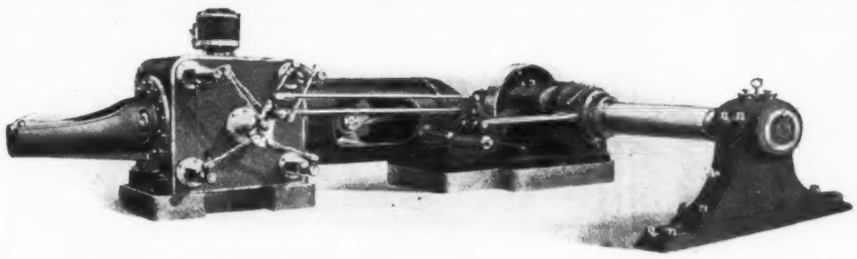
CHESTER, PENNSYLVANIA.

CORLISS STEAM ENGINES

Manufacturers

POWER PLANTS BOILERS

The Valve Travel Never Varies



The Clark Heavy Duty Corliss Engine

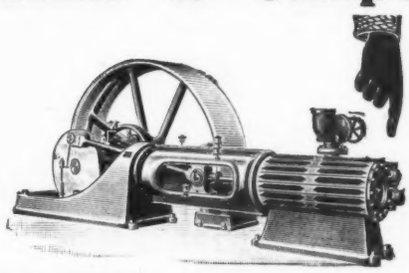
is unequalled for close regulation, low steam consumption and durability without repairs.

These advantages result from perfect valve seats, heavy duty bed with bored guide, extra large main bearings, and numerous other features for which write.

Clark Brothers Company, - Belmont, N. Y.

Positive Adjustments to Compensate for Wear

The Fitchburg Steam Engine is guaranteed to equal, any engine made, in fuel economy, in workmanship and materials and in durability.



Inclose regulation, adaptability to any service and in positive adjustments to compensate for wear, no other engine can equal the Fitchburg.

FITCHBURG STEAM ENGINE COMPANY, FITCHBURG, MASS.

E. H. Ludemann & Co., 165 Broadway, New York. H. J. Gebhardt, 1419 Fisher Building, Chicago.
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A Standard of Excellence Is The Cooper Corliss.

Our Engines are unsurpassed for Rolling Mill and Direct Connected Electric Service. Built in a modern up-to-date Plant. Write!

The C. & G. Cooper Co., Mt. Vernon, Ohio.

Branch Offices:

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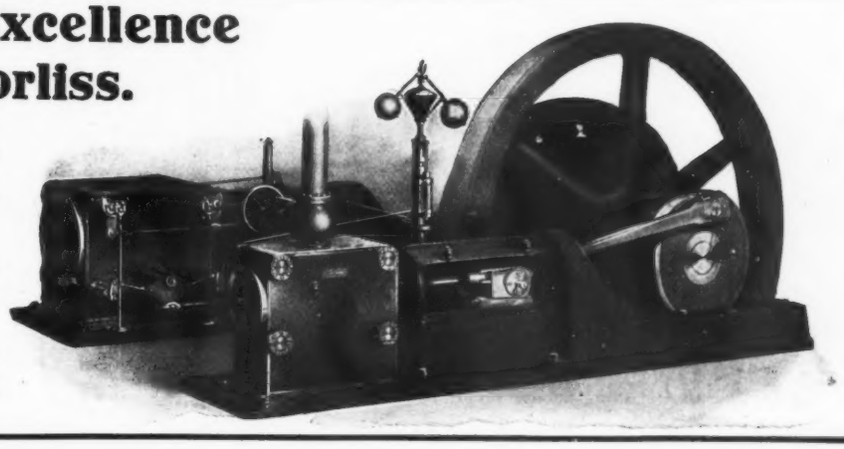
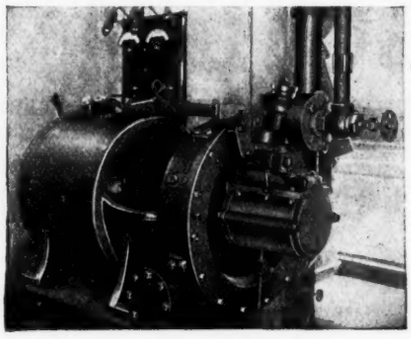


Small Curtis Turbines

are simple and compact.



The Curtis Turbine Generating Unit with switchboard forms the most compact and easily operated set ever placed at the service of the small plant engineer.

The Small Curtis Steam Turbine easily leads other types of generating apparatus in simplicity and compactness of design and construction.

The revolving parts consist simply of a shaft, a group of turbine wheels, an armature and a governor—and that's all.
There is no flywheel, no piston, piston rod, cross head, wrist pin, connecting rod, crank, eccentric, dashpot, rocker arm or other trouble maker.

Until this Curtis Turbine Generator was developed, the vertical reciprocating steam engine set of the marine type was the most compact set in general use

But

The turbine sets require only about half the cubical space required by vertical engines of the same capacity, and less than half the floor space of a horizontal engine.

1280

General Electric Company

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Sales Offices in all large cities.

Lammert & Mann

Engineers and Machinists

157 S. Jefferson Street, CHICAGO

WE MAKE A SPECIALTY OF

Corliss Engine Repairs. Engines Indicated.
General Jobbing. Repairing Engines.
Pumps, etc., all kinds Special Machinery.
Pulleys, Hangers, Shafting, etc. Oil Dash Pots.

YOURS

ON A MINUTE'S NOTICE

We have for immediate delivery:

One 18-inch by 42-inch girder frame engine, left hand, 90 revolutions, rated at 250 h.p.; wheel 14-ft. diameter by 48-inch face.

One 19-inch by 42-inch girder frame engine, right hand, 100 revolutions, rated at 280 h.p.; wheel 14-ft. diameter by 33-inch face.

The above are new engines.

One 14-ft. diameter by 28-inch face pulley, turned for belt. Hub bored 11-inches diameter. Wheel weighs 15,000 pounds.

Get busy and communicate with us.

C. H. BROWN ENGINE CO., Inc.
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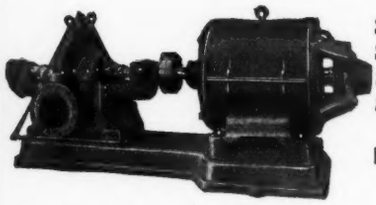
Chicago Representative—FRANK H. POND & Co., Fisher Bldg.

DE LAVAL



De Laval D. C. Motor-Driven Pump.

Steam Turbine Motors
Steam Turbine Dynamos
Steam Turbine Blowers
Steam Turbine Centrifugal Pumps
Electric-Motor Centrifugal Pumps

Send for Catalog No. 20.

DE LAVAL STEAM TURBINE CO., Trenton, N.J.

ENGINE AND BOILER BARGAINS

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20 x 42 Allis, Corliss	16 x 32 Buckeye, Automatic
18 x 42 Hamilton Corliss	14 x 24 Atlas, Automatic
18 x 36 Wright, Corliss	13½ x 15 Taylor, Automatic
14 x 24 Wright, Corliss	12 x 18 Brownell, Automatic
12 x 24 Wetherill, Corliss	12 x 14 Green, Automatic
10 x 30 Hamilton, Corliss	12 x 12 N. Y. Safety, Automatic

Also large assortment of Automatic and Throttling Engines of other sizes.

BOILERS

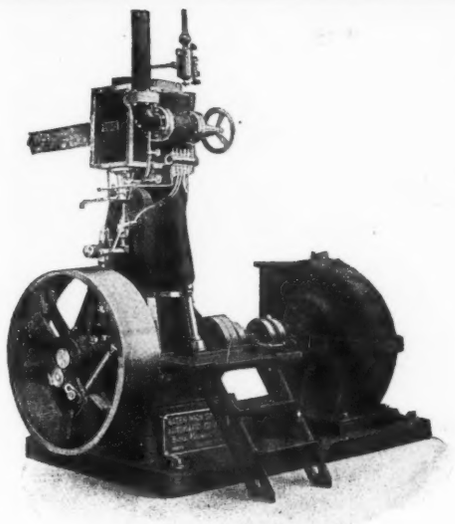
84 x 18, 78 x 16, 72 x 18 High Pressure, 72 x 16, 66 x 16 and smaller sizes of Horizontal Tubular Boilers, also Vertical and Fire Box Boilers from 5 to 60 H P.

Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc.

Write for bargain list.

We are the sole manufacturers of the celebrated "Leader" Injectors and Jet Pumps.

THE RANDLE MACHINERY CO.
1768 Powers St., CINCINNATI, OHIO.



Bates Vertical Automatic High Speed Engine for connection to Pumps. Especially adapted for

WATER WORKS, IRRIGATION

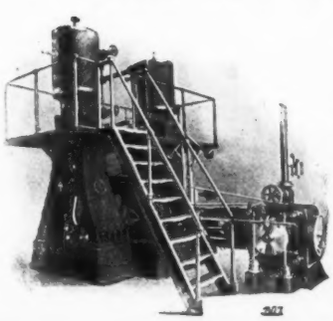
and other places where it is desired to move a large volume of water at small expense.

CATALOG FOR THE ASKING.

BATES MACHINE CO., Joliet, Ill.

York Manufacturing Co.

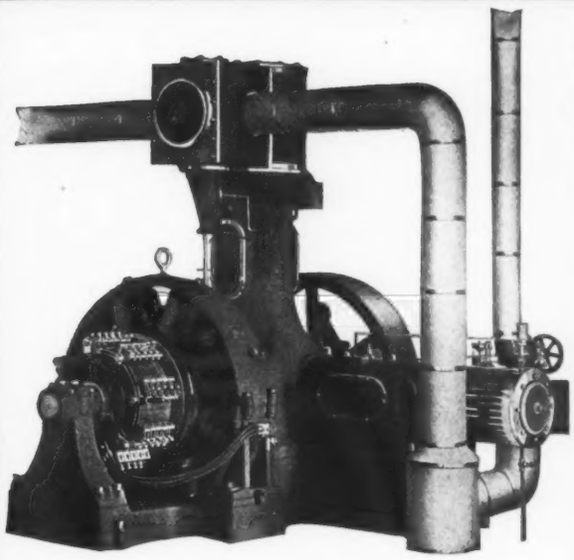
York, Pennsylvania



We manufacture all machinery and parts needed to equip a complete Ice or Refrigerating plant—

Machines, Condensers, Tanks, Cans, Coolers, Piping, Boilers and Ammonia Fittings.

of all kinds. We employ over 1,250 men in the manufacture of Ice and Refrigerating Machinery exclusively. Catalogue sent upon request.



The Engine For Driving Alternators

Where two alternating current electrical generators are run in parallel, their efficiency and regulation depend upon other things than the generators themselves. If the two generators are driven by engines of different types, or even by two ordinary engines of the same size and type but with the piston not moving in unison, cross-currents are set up, which waste power, reduce the capacity of the generator and interfere with the voltage regulation.

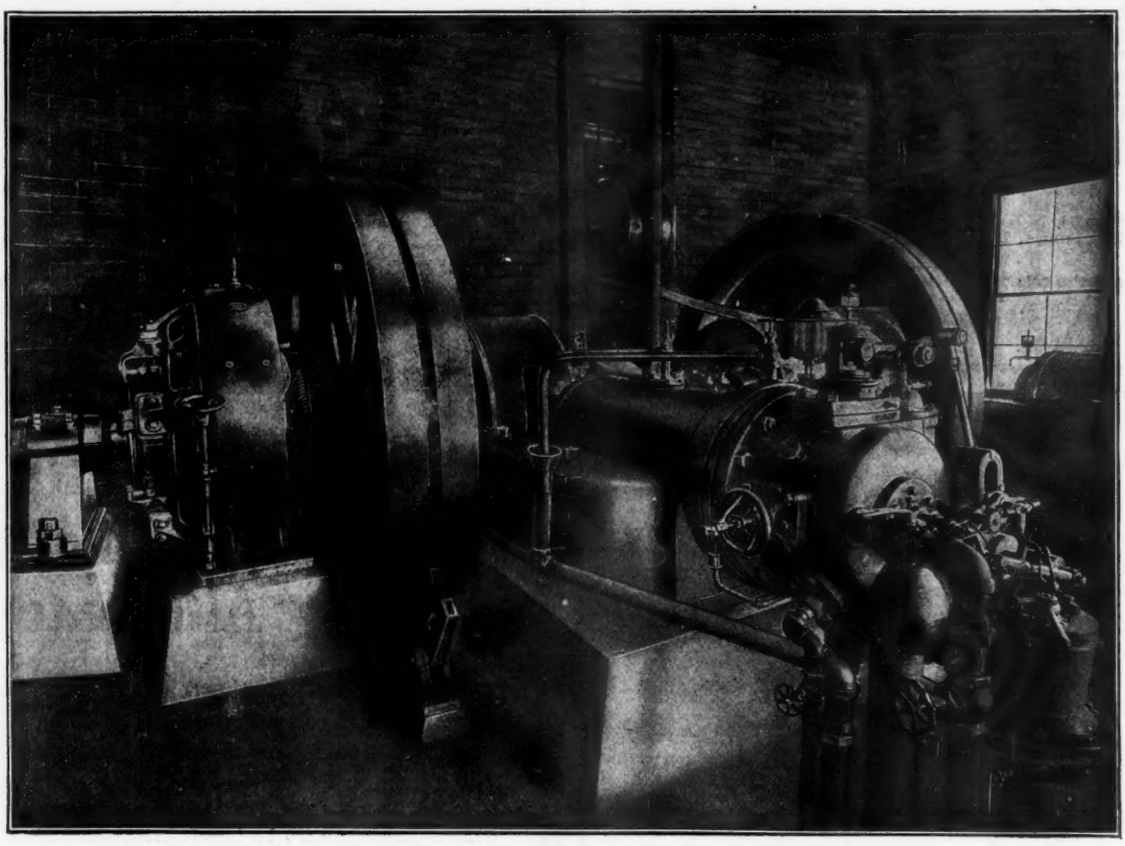
The desirable condition, therefore, in alternator driving is to have the turning moment of the prime mover absolutely uniform throughout a revolution. This can be attained, together with perfect conditions for balancing and high steam economy and in the least possible space, by setting the cylinders at right angles, so that the greatest effort of the one occurs at the time of the least effort of the other, resulting in a practically uniform turning moment throughout the revolution.

This is one of the advantages of the American-Ball Compound Engine. Other advantages realized at the same time are smooth, quiet running, small foundations and floor space and excellent regulation.

Write for our Treatise on Compounds.

American Engine Co.,
21 Raritan Ave. Bound Brook, N. J.

14



Nuenzel Gas Engine and Suction Producer Plant

The above cut shows one of the direct connected units in the Power Plant of the M. & St. L. R'y shops—where we have four different Engines.

"This Engine ran day and night without a single stop for 92 days—when shut down for examination was in perfect condition."—*From operator's report.*

How about reliability?

Minneapolis Steel and Machinery Co.,

Minneapolis, Minn.

Bulletin

GREASE WINS

Grease	Is Cheaper	Is Better	Is Cleaner
Oil	Expensive	Unreliable	Mussy

That man is extravagant nowadays who uses oil as an engine lubricant, when he can get far better results for much less money by using

KEYSTONE GREASE

In all tests that have been made, and they are many, **Keystone Grease** has shown the lowest coefficient of friction of any lubricant known. One pound of **"Keystone"** lasts longer and lubricates better than 3 to 4 pounds of any other grease or 4 to 6 gallons of the best oil. It is clean and pure; every particle lubricates; no gum or sediment is left; friction is reduced to the vanishing point and finest, most economical results are guaranteed. That's why **Keystone Grease** always wins.

KEYSTONE TRADE MARK REGISTERED U.S. PAT. OFF.

See Our Advertisement On Page 3.

Keystone Lubricating Company,

ADDRESS DEPT. B. **Philadelphia, Pa.**

New England Office—10 Oliver St., Boston, Mass.
New York City Office—96 Warren St.
Southern Office—610 Chartres St., New Orleans, La.
Chicago Office—1210 Tacoma Bldg.
Northwestern Office and Warehouse—502 McPhee Bldg., Denver, Col.
San Francisco Office and Warehouse—268 Market St.

Because PALMETTO TWIST unlike Asbestos wick or cotton yarn, never becomes hard, carbonized nor will it cake on the stem no matter how high the temperature or how great the pressure may be.

Pack an ordinary gate valve on the main steam line with asbestos wick or cotton yarn and if that valve stays open any length of time, the next time it is closed and again opened, ten chances to one it blows.

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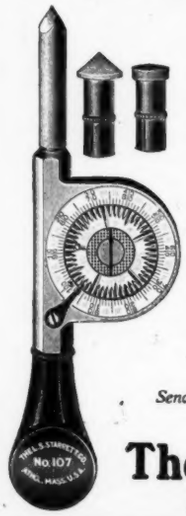

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